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VEGETATION

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In the Nevada/Utah study area the principal vegetation types are arid shrublands with grazing the principal land use. North-south trending valleys are separated by mountain ranges dominated by woodlands, brushlands, and sparse forests. Agriculture is essentially confined to valley bottoms where the principal crop is alfalfa hay used for supplemental livestock feeding. Nevada counties in the study area range from about 0.2 to 2 percent cropland; Utah counties in the study area have slightly more cropland, ranging from about 1 to 4 percent.
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In the Texas/New Mexico study area, irrigated croplands and heavily grazed rangelands predominate. The natural vegetation consists of short grass prairie. Most Texas counties in the study area are more than 50 percent cropland, whereas the New Mexico counties, except for Curry, have less than 30 percent cropland. Rangelands predominate in New Mexico counties (U.S. Dept. of Commerce, 1974b).

The native vegetation in both study areas is an important resource. Vegetation slows the process of wind and water erosion, aids in percolation of precipitation to groundwater storage, reduces flooding and sedimentation, builds desirable soil characteristics, and provides habitat for wildlife. Vegetation is at the base of the food chain, it is the basic resource for the range livestrock industry, provides an environment for recreation, and has aesthetic values. Rare plants and unique vegetation are also components of the natural vegetation which require protection.

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ENVIRONMENTAL CHARACTERISTICS OF ALTERNATIVE DESIGNATED DEPLOYMENT AREAS: NATIVE VEGETATION

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By

Henningson, Durham & Richardson
Santa Barbara, California

22 December 1980

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INTRODUCTION

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VEGETATION - NEVADA/UTAH

The vegetation of the potential deployment area in Nevada/Utah is described in general units, called vegetation types, that are widespread, associated with definable topographic, soil, or other environmental factors, and constitute recognizable types that can be mapped with a reasonable degree of accuracy (Figure 1). The study area includes western Utah, and most of the state of Nevada. Most of this territory lies within the Great Basin Floristic Province, as outlined by Cronquist et al. (1972), Daubenmire (1978), and others. A much smaller area in southern Nevada and southwestern Utah is part of the Mojave Desert, in the Hot Desert Floristic Province. Common plants of the Nevada/Utah study area are listed in Table 1.

The major vegetation types found in this region include:

Alkali Sink Scrub
Creosote Bush Scrub (Mojave Desert Scrub)
Wash and Arroyo Vegetation
Desert Marsh and Spring Vegetation
Riparian (Streambank) Woodland
Shadscale Scrub
Great Basin Sagebrush
Pinyon-Juniper Woodland
Pine-Oak Forest
Fir-Aspen Forest
Montane Brush
Spruce-Fir Forest
Alpine (above timberline)

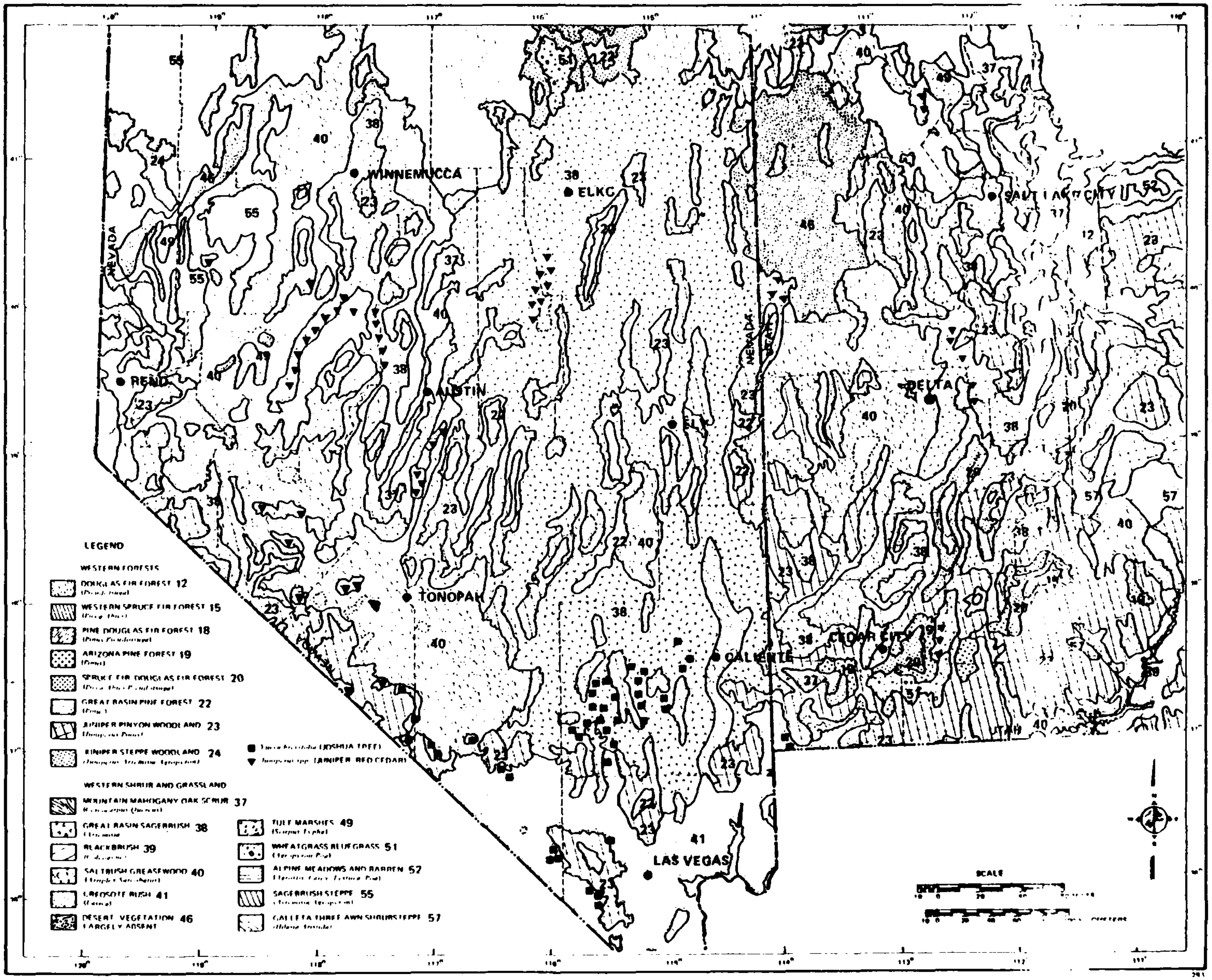

Figure 1. Natural vegetation of the Nevada/Utah study area (Kuchler, 1975).

Table 1. Some common native and naturalized plants of the Nevada/Utah study area[1] (Page 1 of 2).

HYDRO-GRAPHIC UNIT NUMBER	LOCATION	A	S	Q	HYDRO-GRAPHIC UNIT NUMBER	LOCATION	A	S	Q
3	Deep Creek	H	I	H	151	Antelope	L	L	L
4	Snake	H	H	H	152	Stevens	L	L	L
5 (U)	Pine	I	L	L	153	Diamond	I	I	H
6	White	L	L	L	154	Newark	L	L	L
7	Fish Springs	I	H	H	155	Little Smokey	I	H	H
8	Dugway	L	L	L	156	Hot Creek	H	H	H
9	Government Creek	L	L	L	169a	Tikaboo-Northern	H	I	H
13	Rush	L	L	L	170	Penoyer	L	L	L
32b	Great Salt Lake Desert-Western Desert	H	I	H	171	Coal	L	L	L
					172	Garden	H	I	H
46	Sevier Desert	I	H	H	173a	Railroad-Southern	I	I	H
46a	Sevier Desert-Dry Lake	L	L	L	173b	Railroad-Northern	I	H	H
47	Huntington	L	L	L	174	Jakes	L	L	L
50	Milford	L	L	L	175	Long	L	L	L
52	Lund District	L	L	L	176	Ruby	H	H	H
53 (N)	Pine	I	I	H	178	Butte	I	I	H
53 (U)	Beryl-Enterprise District	L	L	L	179	Steptoe	H	I	H
54 (U)	Wah Wah	L	L	L	180	Cave	I	I	H
54 (N)	Crescent	I	H	H	181	Dry Lake	H	I	H
55	Carico Lake	L	L	L	182	Delamar	I	H	H
56	Upper Reese River	H	H	L	183	Lake	I	I	H
57	Antelope	L	L	L	184	Spring	H	H	H
58	Middle Reese River	I	H	L	185	Tippett	L	L	L
122	Gabbs	L	L	L	186	Antelope	L	L	L
124	Fairview	L	L	L	187	Goshute	I	I	H
125	Stingaree	L	L	L	194	Pleasant	I	L	L
126	Cowkick	L	L	L	196	Hamlin	H	I	H
127	Eastgate	L	L	L	198	Dry	I	I	H
133	Edwards Creek	L	L	L	199	Rose	L	L	L
134	Smith Creek	L	L	L	200	Eagle	L	L	L
135	Ione	L	L	L	201	Spring	L	L	L
136	Monte Cristo	L	L	L	202	Patterson	I	I	H
137a	Big Smokey-Tonopah Flat	I	H	L	203	Panaca	I	I	H
137b	Big Smokey-North	I	H	L	204	Clover	L	L	L
138	Grass	L	L	L	205	Meadow Valley Wash	I	H	H
139	Kobeh	I	I	H	206	Kane Springs	L	H	H
140	Monitor	H	H	H	207	White River	H	H	H
141	Ralston	I	H	L	208	Pahroc	L	L	L
142	Alkali Spring	I	I	H	209	Pahranagat	H	H	H
143	Clayton	H	I	H	210	Coyote Springs	H	H	H
144	Lida	I	H	H	219	Muddy River Springs	L	L	L
149	Stone Cabin	L	H	H	128*	Dixie	L	L	L
150	Little Fish Lake	I	H	H	129*	Buena Vista	L	L	L
					132*	Jersey	L	L	L

2292-2

A = Abundance

S = Sensitivity to impact

Q = Quality of data

H = High; I = Intermediate; L = Low

Table 1. Some common native and naturalized plants of the Nevada/Utah study area[1] (Page 2 of 2).

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4	Snake	H	H	H
5 (U)	Pine	I	L	L
6	White	L	L	L
7	Fish Springs	I	H	H
8	Dugway	L	L	L
9	Government Creek	L	L	L
13	Rush	L	L	L
32b	Great Salt Lake Desert-Western Desert	H	I	H
46	Sevier Desert	I	H	H
46a	Sevier Desert-Dry Lake	L	L	L
47	Huntington	L	L	L
50	Milford	L	L	L
52	Lund District	L	L	L
53 (N)	Pine	I	I	H
53 (U)	Beryl-Enterprise District	L	L	L
54 (U)	Wah Wah	L	L	L
54 (N)	Crescent	I	H	H
55	Carico Lake	L	L	L
56	Upper Reese River	H	H	L
57	Antelope	L	L	L
58	Middle Reese River	I	H	L
122	Gabbs	L	L	L
124	Fairview	L	L	L
125	Stingaree	L	L	L
126	Cowkick	L	L	L
127	Eastgate	L	L	L
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134	Smith Creek	L	L	L
135	Ione	L	L	L
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137a	Big Smokey-Tonopah Flat	I	H	L
137b	Big Smokey-North	I	H	L
138	Grass	L	L	L
139	Kobeh	I	I	H
140	Monitor	H	H	H
141	Ralston	I	H	L
142	Alkali Spring	I	I	H
143	Clayton	H	I	H
144	Lida	I	H	H
149	Stone Cabin	L	H	H
150	Little Fish Lake	I	H	H

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151	Antelope	L	L	L
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180	Cave	I	I	H
181	Dry Lake	H	I	H
182	Delamar	I	H	H
183	Lake	I	I	H
184	Spring	H	H	H
185	Tippett	L	L	L
186	Antelope	L	L	L
187	Goshute	I	I	H
194	Pleasant	I	L	L
196	Hamlin	H	I	H
198	Dry	I	I	H
199	Rose	L	L	L
200	Eagle	L	L	L
201	Spring	L	L	L
202	Patterson	I	I	H
203	Panaca	I	I	H
204	Clover	L	L	L
205	Meadow Valley Wash	I	H	H
206	Kane Springs	L	H	H
207	White River	H	H	H
208	Pahroc	L	L	L
209	Pahranagat	H	H	H
210	Coyote Springs	H	H	H
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Vegetation types discussed in detail below are alkali sink scrub, creosote bush scrub, wash and arroyo vegetation, desert marsh and spring vegetation, riparian woodland, shadscale scrub, Great Basin sagebrush, and pinyon-juniper woodland (Figure 2). These types are found in the valley bottoms and low bajadas and occur in the suitable areas for M-X deployment and therefore are most likely to be directly impacted by the project. A discussion of forest resources is also included.

Alkali Sink Scrub: Alkali sink scrub vegetation is found at low elevations throughout the project area, in valley bottoms, especially around playa margins, in saline or alkaline clay soils. This vegetation is composed of a very open growth of shrubs one meter or less in height and low herbs. The shrubs are green or gray-green, depending upon the species and season of the year. Flowering occurs in spring and is generally inconspicuous.

Alkali sink scrub is dominated by a limited number of halophytic shrubs and herbs. Greasewood (*Sarcobatus vermiculatus*) often forms pure or nearly pure stands. Iodine bush (*Allenrolfea occidentalis*) and saltgrass (*Distichlis spicata*) dominate areas too salty for greasewood; for example, they often form the inner fringe of vegetation around barren playas, or separate upland communities from salt marsh communities (Cronquist et al, 1972).

Field studies and current literature show that dominant species of this vegetation type found within the project area include:

Scientific Name	Common Name
Allenrolfea occidentalis	Iodine bush
Artemisia spinescens	Bud sage
Atriplex confertifolia	Shadscale
Atriplex lentiformis	Saltbush
Bassia hyssopifolia	Hyssop-leaved bassia
Distichlis spicata var. *stricta*	Saltgrass
Glaux maritima	Black saltwort
Halogeton glomeratus	Halogeton
Haplopappus lanceolatus	Intermountain pyrrocoma
Hutchinsia procumbens	Prostrate hutchinsia
Iva axillaris	Poverty weed
Juncus balticus var. *montanus*	Baltic rush
Kochia americana	Red sage, red molly
Salicornia spp.	Pickleweed
Salsola iberica	Russian thistle
Sarcobatus vermiculatus	Greasewood
Sporobolus airoides	Alkali saccaton
Suaeda nigra	Black sea-blite
Thelypodium sagittatus	Sagittate thelypodium

This community is sometimes invaded by *Halogeton glomeratus*, a Central Asian weed that is toxic to livestock (Cronquist et al., 1972). Halogeton tends to become established and spread rapidly in areas of alkaline soil that have been disturbed. The characteristics of halogeton establishment and its potential for reducing the quality of rangelands are discussed further under shadscale scrub, the community in which it is most commonly found. Sources of present disturbance to

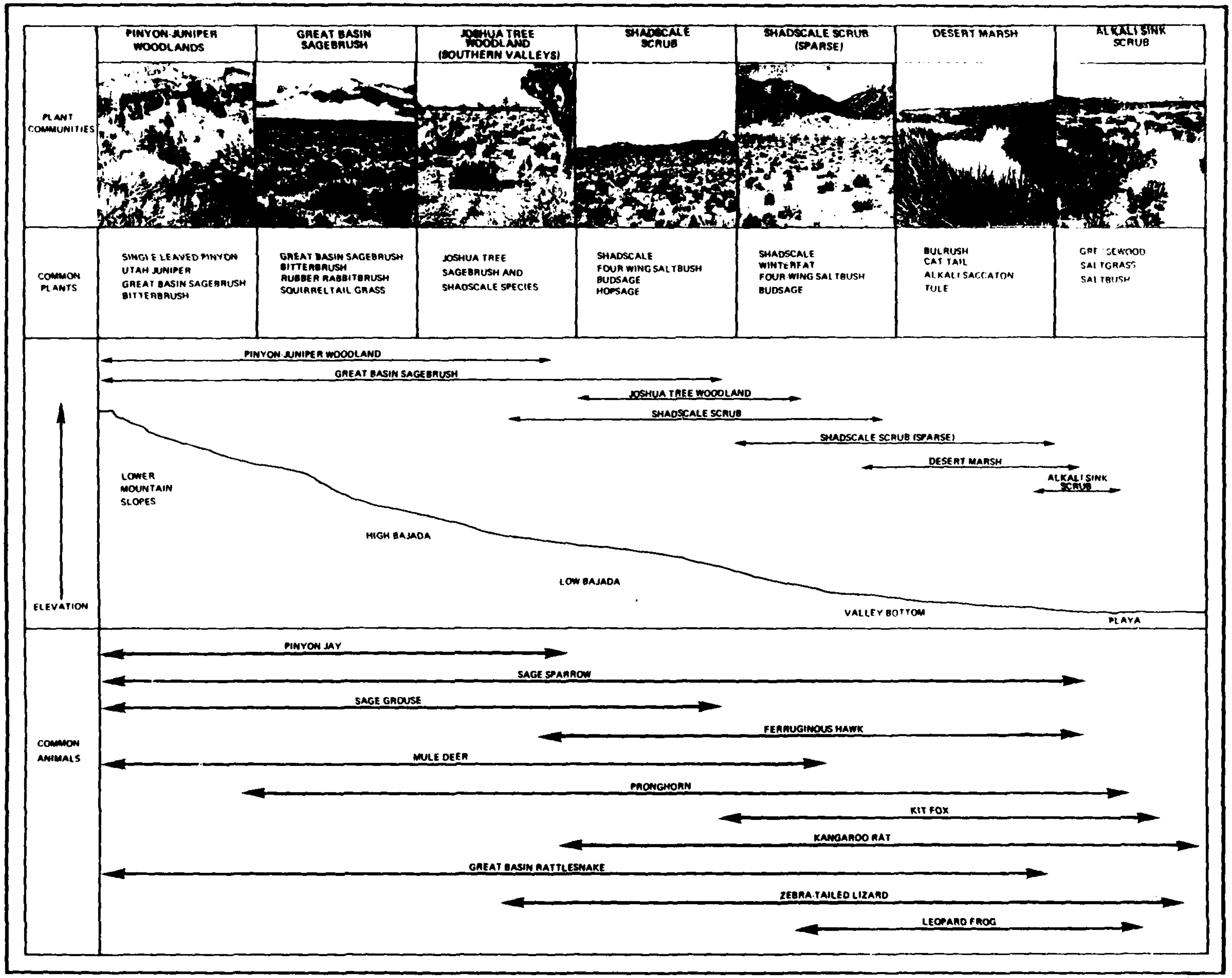

Figure 2. Plant and animal relationships along an elevational gradient in the Nevada/Utah study area.

this vegetation include use as grazing pasture and as off-road vehicle recreation areas. Effects of off-road vehicles on vegetation and soils are discussed further in the section below entitled creosote bush scrub.

Successional characteristics and recovery potential of this vegetation type are unknown.

Creosote Bush Scrub: Creosote bush scrub is a widespread shrub community of the Mojave and Sonoran deserts. The form of this type found in the Mojave Desert is sometimes referred to as Mojave Desert scrub. In the Nevada/Utah study area, this vegetation is found in southern Nevada and in the southwest corner of Utah, in dry areas of low topographic relief, usually below 4,000 ft, although the dominant species, creosote bush, may occur in Nevada up to 5,200 ft (Beatley, 1976). This vegetation has been well-studied by Beatley at the Nevada Test Site and other areas in south-central Nevada (Beatley, 1976).

Creosote bush scrub is found on bajadas and other areas of gradual relief. Mean rainfall, measured over a ten-year period from 1962 through 1972 at several stations at the Nevada Test Site, was 4.7 to 6.2 in., with annual variation in the general range of 2 to 13 in. Mean maximum temperatures for all seasons were approximately 81 to 87 degrees F, and mean minimums 29 to 40 degrees F, with extreme maximum 117 degrees F, and extreme minimum -8 degrees F (Beatley, 1976).

This vegetation is dominated by the creosote bush, *Larrea divaricata*, the most common shrub of these areas, that usually occupies the upper layer of the two-layered shrub community. The size and density of this shrub vary with local moisture conditions, but it is the largest and most common shrub of this vegetation type. Total shrub cover varies from 7 to 23 percent, and average height from 0.2 to 0.9 m. Herbaceous perennials, grasses, and summer- and winter-flowering annuals are abundantly represented in this vegetation (Beatley, 1976).

Field studies and literature show that dominant shrubs of this vegetation type within the project area include:

Scientific Name	Common Name
Acamptopappus shockleyi	Shockley goldenhead
Ambrosia dumosa	Bursage
Atriplex confertifolia	Shadscale
Dalea fremontii	Indigo bush
Encelia farinosa	Brittle bush
Ephedra funerea	Ephedra
E. torryana	Torrey ephedra
Eurotia (Ceratoides) lanata	Winterfat
Grayia spinosa	Hopsage
Haplopappus cooperi	Goldenbush
Krameria parvifolia	Krameria
Larrea divaricata	Creosote bush
Lycium andersonii	Anderson's boxthorn
L. pallidum	Boxthorn
L. shockleyi	Shockley's boxthorn

Menodora spinescens	Spiny menodora
Opuntia spp.	Beavertail, cholla
Yucca brevifolia	Joshua tree
Y. schidigera	Mojave yucca

One distinctive association or subtype found within the creosote bush scrub vegetation is Joshua tree woodland, dominated by the arborescent monocot Yucca brevifolia. This association is found high on alluvial fans, in areas of well-drained soil that receive a little more rainfall than is typical of creosote bush scrub in general. The Joshua tree forms open groves, with an understory of shrubs, perennial and annual herbs and grasses. This species is also found with an understory of shadscale scrub or Great Basin sagebrush vegetation (Cronquist et al., 1972).

Blackbrush, or blackbush (Coleogyne ramosissima), is a low shrub that occurs in pure stands in a subtype that is transitional between creosote bush scrub and shadscale scrub (Cronquist, 1972; Beatley, 1976).

A major source of disturbance to this vegetation type at the present time is the use of off-road vehicles. The biological effects of these vehicles in the Mojave Desert have been documented and include changes in physical soil characteristics, increased erosion, and loss of topsoil (Webb, 1978; Davidson, 1974; Wilshire et al., 1978), destruction of shrubs and other plants, decrease in seedling survival and a reduction in revegetation potential (Wilshire et al., 1978). Effects on wildlife have also been documented (Busack, 1974; Luckenbach, 1975). Use of ORVs in the Mojave is extensive, including that for heavily attended events such as the Barstow to Las Vegas Enduro (an off-road motorcycle race) and more widespread, generalized use. Impacts of ORV use in the Great Basin are less well documented but are expected to be comparable.

In general, reliable data are seldom available for accurately determining the successional patterns of native vegetation types, especially those of the desert. For the Mojave Desert, estimates of patterns and recovery rates have been made, based on observations of the historical sequence of events in areas cleared for pipelines, roads, transmission lines, in areas cleared by nuclear tests, and in the streets of abandoned mining towns. Recovery rate estimates are also based on the response to disturbance of Sonoran Desert vegetation. Estimates of time required for Mojave Desert vegetation to recover after perturbation are 100 years or more.

Kay (1979) studied plant establishment in the creosote bush scrub vegetation type along the Los Angeles aqueduct north of Mojave, California, nine years after it was constructed. His results showed that bursage (Ambrosia dumosa), desert saltbush (Atriplex polycarpa), and cheesebush (Hymenoclea salsola) reestablished naturally in equal or greater numbers than observed in adjacent undisturbed locations. Creosote bush (Larrea divaricata) and Nevada ephedra (Ephedra nevadensis) have reestablished population levels of less than 20 percent of those observed in undisturbed areas. Rubber rabbitbrush (Chrysothamnus nauseosus), although rare in the undisturbed community, was found abundantly in the disturbed corridor. Numerous Eurasian weeds, observed in the disturbed areas, were thought to inhibit shrub establishment through competition for water and nutrients. Kay states that eight years after aqueduct construction, over half of the disturbed area remained relatively bare.

Shields and others (1963) characterized the recovery of vegetation at nuclear test areas in the northern Mojave Desert in Nevada. They observed that, initially, the weedy exotic annual, Russian thistle (Salsola iberica), invaded denuded areas, followed by spring annuals. There was an increasing encroachment of red brome (Bromus rubens), an introduced annual grass. They felt that fourwing saltbush (Atriplex canescens) and cheesebush (Hymenoclea salsola) would be dominant shrubs, and that Indian mountain-rice (Oryzopsis hymenoides) and needlegrass (Stipa spp.) would be expected to assume dominance following initial invasion by annuals. The invasion of the dominant shrubs of the nearby climax vegetation was expected to follow the bunchgrasses, and to be gradual.

Wells (1961) studied the vegetation that had become established on the streets of Wahmonie, a Nevada ghost town in the northern Mojave, during the 33-year period since it was abandoned. He found that the desert shrub community of the surrounding uplands, composed of species of the creosote bush scrub and shadscale scrub vegetation types, had been replaced by a community dominated by desert needlegrass (Stipa speciosa) and shrubs not characteristic of the uplands, but found in nearby naturally disturbed habitats, such as washes. Less than 20 percent of the shrub species were similar in density and frequency in both disturbed and nearby undisturbed areas. He concluded that invasion by shrubs characteristic of the predisturbance community had been slow, and that the species composition of the disturbed area was different, qualitatively and quantitatively, from its original composition.

Based on these studies and an estimate by the National Academy of Sciences (1974) that recovery of native vegetation in areas receiving less than ten inches of annual precipitation will require decades to centuries, recovery of creosote bush scrub is expected to require a minimum of 100 years.

Wash and Arroyo Vegetation: Washes and arroyos with distinctive vegetation are found in the southern part of the Nevada potential deployment area, within the Hot Desert Floristic Province and within the transition area between this province and the Great Basin Floristic Province. A number of valleys near Las Vegas, for example, Coyote Spring and Lower Meadow Valley Wash, contain this vegetation.

Washes and arroyos are distinguished in this report by size. Washes are larger and include dry stream courses and major drainage channels. Arroyos are smaller, and include subsidiary drainage channels that feed into washes. Both contain surface water at very irregular intervals, although water may be normally present at some depth beneath the surface.

Wash and arroyo vegetation includes medium-sized to large shrubs and some perennial and annual herbs and grasses. In some washes and arroyos, the vegetation is not distinctive from that of the surrounding uplands, usually creosote bush scrub, or shadscale scrub. In most areas, wash and arroyo vegetation includes some species that are characteristic of the surrounding uplands and some that are distinctive to washes and arroyos.

Field studies and literature show that common distinctive shrub species of this community include:

Scientific Name	Common Name
Ambrosia eriocentra	Wooly-fruited burbush
Baccharis glutinosa	Mule fat
Chilopsis linearis	Desert willow
Chrysothamnus paniculatus	Punctate rabbitbrush
Encelia virginensis	Desert encelia
Fallugia paradoxa	Apache plume
Haplopappus linearifolius	Goldenbush
Prosopis glandulosa	Mesquite
Prunus fasciculata	Desert almond
Quercus turbinella	Desert scrub oak
Salazaria mexicana	Bladder sage
Salvia dorrii	Desert sage

Desert washes and arroyos experience relatively frequent natural disturbances, usually in the form of flash floods. Infrequent heavy rains produce large amounts of surface runoff water that rapidly fills wash and arroyo channels. These waters carry sediment and rocks, often scouring the channels and carrying away vegetative debris. Some wash and arroyo species have special adaptations that promote their rapid reestablishment after this kind of disturbance. Larger washes often support denser vegetation than the surrounding uplands, and may be used more heavily for cattle grazing.

Successional characteristics and rate of succession have not been determined for vegetation of washes and arroyos.

Desert Marsh and Spring Vegetation: Descriptive literature about the vegetation of marshes and springs within the study area is limited. Beatley (1976) described the spring and seep areas of Ash Meadows, which may be considered representative of the wetlands of south-central Nevada.

Bolen (1964) describes the vegetation of spring-fed salt marshes in western Utah, and Flowers (1934) gives descriptions for similar areas around the Great Salt Lake. These studies give incomplete coverage to the vegetation which provides critical habitat for desert wildlife. Further detailed studies of these habitats within the project area are being carried out.

Desert springs and marshes are found scattered throughout the study area, most commonly in low elevation "wet" valleys where the water table lies near the ground surface. Springs are found in areas where fresh water reaches the soil surface from underground reservoirs. Spring waters may be contained in pools, or more commonly they overflow small pools to saturate low-lying basins nearby. These moist flats support marsh vegetation that varies floristically according to the local salinity characteristics of the soil and water. Spring and marsh vegetation are included within the category of desert wetland vegetation.

Spring and marsh vegetation may be similar in aspect and floristics, although there are some distinct differences. For example, the low, salt-tolerant plants of saline marshes are not found around springs. In general, vegetation near springs is lush and green, especially during the summer months, and contrasts sharply with the surrounding desert scrub. Springs may be surrounded by small trees, large shrubs,

and an abundant growth of mainly perennial herbs and grasses. In some cases, trees and shrubs are lacking, and there is a dense growth of low plants. When trees and shrubs are present, they are commonly of Fremont cottonwood (Populus fremontii), willows (Salix exigua and S. gooddingii), and velvet ash (Fraxinus velutina).

Marsh vegetation varies considerably in aspect and species composition according to soil salinity. Fresh to brackish water marshes are dominated by relatively tall perennial herbaceous monocots such as cattails (Typha spp.), tules (Scirpus spp.), and grasses. Saltmarshes have a submersed flora described by Bolen (1964), in addition to a distinct emergent flora of rushes (Juncus spp.), tules (Scirpus spp.), and other salt-tolerant perennials such as saltgrass (Distichlis spicata), spikerush (Eleocharis rostellata), and Triglochin maritimum.

The species lists below are based on field studies and literature. Trees and shrubs associated with desert springs include:

Scientific Name	Common Name
Atriplex lentiformis	Saltbush
Baccharis emoryi	Emory baccharis
Fraxinus velutina var. coriacea	Velvet ash
Populus fremontii	Fremont cottonwood
Prosopis glandulosa var. torreyana	Mesquite
P. pubescens	Screw-bean mesquite
Rosa woodsii	Wild rose
Salix exigua var. stenophylla	Narrow-leaved willow
S. gooddingii	Gooding's willow
Sarcobatus vermiculatus	Greasewood
Suaeda torreyana var. torreyana	Torrey's sea-blite

Common desert marsh plants include:

Scientific Name	Common Name
Allenrolfea occidentalis	Iodine bush
Anemopsis californica	Yerba mansa
Atriplex hastata	Hastate-leaved saltbush
Atriplex spp.	Saltbush species
Berula erecta	Water-parsnip
Castilleja exilis	Indian paintbrush
Distichlis spicata var. stricta	Saltgrass
Eleocharis rostellata	Spikerush
Eleocharis spp.	Spikerush species
Juncus balticus var. montanus	Baltic rush
Helianthus nuttallii	Nuttall's sunflower
Hordeum jubatum	Squirrel tail
Phragmites australis	Common reed
Puccinellia nuttalliana	Nuttall's alkali grass
Ranunculus cymbalaria	Desert buttercup
Salicornia spp.	Pickleweed species
Scirpus acutus	Tule
S. americanus	Three-square

S. maritimus var. paludosus	River bulrush
S. olneyi	Olney's bulrush
Solidago spp.	Goldenrod species
Sporobolus airoides	Alkali saccaton
Tamarix ramosissima	Tamarisk, salt cedar
Triglochin maritimum	Seaside arrow-grass
Typha latifolia	Cat-tails

Most marshes and springs of significant size experience some forms of disturbance. Present sources of disturbance to springs and marshes include damming and impounding of water to produce livestock watering areas, trampling of emergent and bank vegetation by domestic and feral livestock, and pollution and sedimentation from these sources and from recreational use.

The successional characteristics and recovery potential of the vegetation of desert springs and marshes are not documented in the literature.

Riparian (Streambank) Woodland: Riparian woodland vegetation is found along the banks of perennial and some intermittent streams throughout the study area, at elevations below 8,000 ft. In Nevada, where perennial streams are uncommon, this vegetation is limited in extent. It occurs in the Pahranagat Valley, White River Valley, Meadow Valley Wash, and elsewhere. In Utah, this vegetation is more extensive and is found along the banks of the Virgin and Sevier rivers, and smaller rivers and streams.

Riparian woodland is characterized by a sparse to moderately dense growth of small to medium-sized mesophytic deciduous trees. The lush aspect of this vegetation contrasts sharply with the sparseness of the surrounding shrublands. Most of the dominant trees flower and leaf out in spring, grow rapidly through midsummer, then gradually become dormant as drought and cold temperatures increase in fall. Leaf drop generally occurs in late autumn, and the trees remain leafless until the following spring.

The dominants of this community are trees and large shrubs, including Fremont cottonwood (Populus fremontii), several species of willow (Salix gooddingii and others), velvet ash (Fraxinus velutina), water birch (Betula fontinalis), and box elder (Acer negundo) (Irvine and West, 1979). The understory contains a dense growth of mesophytic, shade-tolerant shrubs and vines, perennial and annual herbs and grasses. Common woody plants of this riparian woodland vegetation include:

Scientific Name	Common Name
Acer negundo spp. interior	Box elder
Baccharis emoryi	Emory baccharis
Betula fontinalis	Water birch
Cornus stolonifera	American dogwood
Eleagnus angustifolia	Russian dogwood
Fraxinus velutina	Velvet ash
Populus fremontii	Fremont cottonwood
Rosa woodsii	Wild rose
Salix exigua	Narrow-leaved willow
Salix gooddingii	Goodding's willow

S. laevigata	Red willow
S. lasiolepis	Arroyo willow
S. lasiandra spp. caudata	Red willow
Tamarix spp.	Tamarisk species
Vitis arizonica	Canyon wild grape

Sources of present disturbance include trampling of emergent and bank vegetation by domestic and feral livestock, and pollution and sedimentation from trampling and recreational activities.

The successional characteristics and recovery potential of the vegetation of riparian woodlands of the project area have not been documented in the literature.

Shadscale Scrub: Shadscale scrub, referred to as saltbush scrub by some authors, is a wide-ranging shrub community that is abundant in western Nevada and southwestern Utah (Cronquist et al., 1972; Billings, 1954). It may occur on valley bottoms or on rocky slopes. It is considered by some as an edaphic climax community, and tolerates salty soils, but apparently thrives best in areas where the salt content of the soil is relatively low (Kearney et al., 1914). It is tolerant of low moisture regimes, and is common in western Nevada valleys with annual precipitation from 3.5 to 7 in. (Cronquist et al., 1972). It is distinguished from Great Basin sagebrush by floristic, climatic, and elevational characteristics (Billings, 1949).

Shadscale scrub is a shrub community dominated by low, widely spaced, microphyllous, spiny, gray-green shrubs. Cover is often around 10 percent, with much open ground (Barbour and Major, 1977). Some perennial and annual herbs and grasses occur between the shrubs, but these are less common than in creosote bush scrub, especially annual herbaceous species. Growth varies with annual precipitation, and occurs mainly in late spring, as does peak flowering.

The most abundant species of this vegetation type is shadscale (Atriplex confertifolia). The common name of this species is derived from the supposed similarity of its leaves to the scales of a shad. According to current literature and field studies, other important shrub species in this community include the following:

Scientific Name	Common Name
Artemisia spinescens	Bud sage
Atriplex canescens	Four-wing saltbush
A. confertifolia	Shadscale
A. gardneri	Gardner's saltbush
A. nuttallii	Nuttall's saltbush
Chrysothamnus viscidiflorus	Sticky-leaved rabbitbrush
Coleogyne ramosissima	Blackbrush
Ephedra nevadensis	Nevada ephedra
Eurotia (Ceratoides) lanata	Winterfat
Grayia spinosa	Hopsage
Gutierrezia sarothrae	Matchweed
Kochia americana	Red sage
Lycium spp.	Boxthorn species
Menodora spinescens	Spiny menodora
Sarcobatus baileyi	Bailey's greasewood
Tetradymia glabrata	Little-leaf horsebrush

At least two distinctive associations, or subtypes, occur within shadscale scrub vegetation. Blackbrush, or blackbush (Coleogyne ramosissima), often forms pure or nearly pure stands, and is considered by some to be transitional between shadscale scrub and creosote bush scrub (Billings, 1949; Beatley, 1976). It grows on non-saline, often sandy soils, commonly where annual precipitation is below 6 in. It appears as a community of dense to open stands of dark, evergreen shrubs, often interspersed with James' galleta grass (Hilaria jamesii), according to Cronquist et al., (1972). This subtype is most common in the southern part of the project area, for example in Coyote Spring and Kane Springs valleys.

Winterfat (Eurotia lanata) often occurs in pure stands as a subtype of shadscale scrub. The whitish-gray herbage of the plants causes the winterfat areas to stand out among the darker shadscale shrubs. It was assumed for many years that winterfat grows in areas of low salt concentration and relatively high moisture, but Workman and West (1967) found too much variation for it to be thought of as an indicator of these conditions (Cronquisf et al., 1972).

Current sources of disturbance to shadscale scrub include grazing by domestic livestock and off-road vehicle activities. These disturbances result in a loss of vegetative cover and increased erosion.

The available information on shadscale community succession comes primarily from studies on the recovery of this community after intense grazing had occurred. Shadscale communities can increase in vegetative cover on playa fringes and low bajadas after severe grazing pressure (Stewart, Cottam and Hutchings, 1940). Grazing pressure on shadscale communities seems to cause an increase in the shadscale component (Holmgren and Hutchings, 1972), since shadscale is of relatively low palatability to livestock (Stewart et al., 1940). Heavy spring and summer grazing in some areas can completely eliminate stands of winterfat (Stevens et al., 1977), an important forage species in the shadscale community. In areas of intense disturbance from grazing, winterfat has been replaced by rabbitbrush, snakeweed, and saltbush (Stevens et al., 1977).

On the coarse substrates of the bajadas, a disturbance can result in the establishment of Russian thistle (Salsola iberica), which may dominate the site for up to 15 years or more (Stewart et al., 1940). If disturbance is not severe or repeated, Russian thistle will gradually give way to a cover of tumble mustard (Sisymbrium altissimum) to be replaced by tansy mustard (Descurainia spp.) and eventually by cheatgrass, or downy brome (Bromus tectorum) (Piemeisel, 1932, 1938). Under conditions of continued disturbance, this successional sequence will revert back to Russian thistle dominance (Evans et al., 1967).

On finer substrates of the low bajadas and lakeplains, Halogeton glomeratus, a toxic weed introduced from central Asia, quickly establishes after disturbance. Under conditions of light disturbance, halogeton is gradually replaced by rabbitbrush, winterfat, or shadscale. Under more severe or repeated disturbance, halogeton can alter the soil chemistry to the point that native vegetation is excluded (Cook and Stoddart, 1953). Site modification by halogeton may prevent native species reestablishment for over 50 years (Eckert and Kinsinger, 1960). Halogeton is now found throughout most of the shadscale zone and in some lower

elevation areas of the sagebrush zone. Halogeton has reduced or eliminated grazing in many areas since it is toxic to livestock (Cook and Stoddart, 1953). Recent studies suggest that the only effective method for control of halogeton is by competition with perennial species (Cleaves and Taylor, 1979).

Great Basin Sagebrush: Great Basin sagebrush occurs extensively throughout the central and northern parts of the study area, on rocky mountainsides, broad valleys and low foothills from about 5,000 to 10,000 ft elevation. It is the climatic climax of Great Basin desert areas where annual precipitation usually exceeds 7 in. It is best developed on deep, permeable, nonsaline soils of well-drained valleys and mountain bases, especially on alluvial fans (Cronquist et al., 1972). It is viewed as replacing shadscale scrub at higher elevations, where there is somewhat more moisture, and soils are not as saline or alkaline (Billings, 1954).

The aspect of the typical Great Basin sagebrush community is of fairly dense to open gray-green shrubs, usually 1 m or less in height and often with a dense understory of bunchgrasses, especially in relatively undisturbed regions. Perennial herbs are scattered in the understory, although not particularly common, and the annual herbaceous flora is depauperate, with the exception of a variety of introduced, mainly Eurasian, weeds. Ground cover within Great Basin sagebrush varies from about 15 to 40 percent (Cronquist et al., 1972).

The dominant shrub of this vegetation is referred to variously as big, tall, or Great Basin sagebrush (Artemisia tridentata). Several varieties of this species are recognized and other species of Artemisia may dominate the sagebrush community as well. Other important shrub species include rubber rabbitbrush (Chrysothamnus nauseosus), also distinguished by a number of varieties, and bitterbrush or antelope brush (Purshia tridentata), the most important forage species of the community (Nord, 1965).

Relatively undisturbed sagebrush has a dense understory of perennial bunchgrasses, including bluebunch wheatgrass (Agropyron spicatum), Sandberg bluegrass (Poa sandbergii), and Idaho fescue (Festuca idahoensis). According to current literature and field studies conducted for this report, important shrubs of the Great Basin sagebrush community include:

Scientific Name	Common Name
Artemisia arbuscula	Dwarf sagebrush
A. nova	Black sagebrush
A. tridentata	Big sagebrush, Tall sagebrush, Great Basin sagebrush
Chrysothamnus greenei	Green's rabbitbrush
C. nauseosus	Rubber rabbitbrush
C. viscidiflorus	Sticky-leaved rabbitbrush
Coleogyne ramosissima	Blackbrush
Ephedra torreyana	Torrey ephedra
E. viridis	Mormon tea
Grayia spinosa	Hopsage
Leptodactylon pungens	Granite gilia
Prunus andersonii	Desert peach

Purshia tridentata	Antelope brush, Bitter-brush, Deerbrush
Ribes velutinum	Plateau gooseberry
Symphoricarpos spp.	Snowberry species
Tetradymia glabrata	Little-leaved horsebrush

Important perennial grasses of the Great Basin sagebrush community include:

Scientific Name	Common Name
Agropyron dasystachyum	Thickspike wheatgrass
A. smithii	Western wheatgrass
A. spicatum	Bluebunch wheatgrass
Aristida purpurea	Purple three-awn
Bromus carinatus	California brome
Elymus cinereus	Basin wildrye
Festuca idahoensis	Idaho fescue
Koeleria cristata	Junegrass
Oryzopsis hymenoides	Indian mountain-rice
Poa fendleriana	Mutton grass
P. nevadensis	Nevada bluegrass
P. sandbergii	Sandberg bluegrass
Sitanion hystrix	Squirreltail
Sporobolus airoides	Alkali saccaton
Stipa comata	Needle-and-thread grass
Stipa spp.	Needlegrass species

Several important changes have occurred in the Great Basin sagebrush vegetation since about 1840. In central Utah, and probably elsewhere, this vegetation was co-dominated by bunchgrasses, a condition now represented by relictual, relatively inaccessible sites and areas where grazing has been excluded (Christensen and Johnson, 1964; Cottam, 1961). In other areas, sagebrush is more vigorous, and when undisturbed, tends to outcompete the grasses (Pearson, 1965; Robertson, 1947). Climatic differences may be an important factor in determining whether sagebrush or sagebrush-bunchgrass will dominate in a given area. By comparing climatic and phytosociological data in Utah, Christensen (1959) found that areas that received more rainfall had more bunchgrass than sagebrush. The season of precipitation may be important, since winter-maximum areas are dominated by sagebrush, and summer-maximum areas by sagebrush-bunchgrass.

Great Basin sagebrush areas have been used for grazing and farming activities. Much of the farmland of the project area is cleared sagebrush, and many urban areas were previously vegetated with this type (Cronquist et al., 1972). Grazing is widely practiced in the community and has brought about a number of widespread changes. In many grazed areas, the preferred perennial bunchgrasses have been nearly eliminated by overgrazing. In some areas, this has encouraged the encroachment of sagebrush, and in others the annual cheatgrass, or downy brome (Bromus tectorum), has become exceptionally widespread. This annual is not as palatable to livestock as the perennial grasses, and is not reliable forage, since its abundance is largely determined by annual rainfall (Hansen, 1979).

Great Basin sagebrush is not a good browse plant because its herbage contains essential oils that inhibit microbial action in ruminants (Nagy et al., 1964), although

native herbivores (mule deer, pronghorn, and desert bighorn) sometimes graze it, especially that which grows in areas of high water potential (Young et al., 1975). Several management techniques have been used to decrease the amount of sagebrush, and increase the amount of palatable grasses, in grazed areas. Discing and defoliation are the procedures most commonly used. In disced areas, the sagebrush is physically uprooted or crushed by a discing or mowing machine, and the area is later planted with a forage grass, commonly crested wheatgrass (Agropyron cristatum). Defoliation is carried out by spraying the sagebrush with a commercial brand of dicot herbicide, usually consisting of a mixture of 2,4-D and 2,4,5-T. Defoliation kills the shrubs, but it does not physically remove them. Grasses are planted later, and grow thickly between the dead sagebrush. Crested wheatgrass is commonly used in this method, also.

Sources of present disturbance to the sagebrush vegetation include overgrazing by cattle and sheep, discing and defoliant spraying, strip mining and metal smelting, development of urban areas, and effects of off-road vehicles and other forms of recreation.

The successional characteristics of the Great Basin sagebrush community have apparently changed as a result of modifications due to grazing. In the pristine condition, recovery of the Great Basin sagebrush community after disturbance involved an initial domination by either climax perennial grasses, or root-sprouting shrubs with shortlived perennial grasses (e.g., squirreltail grass, (Sitanion histrix); and Sandberg bluegrass, (Poa sandbergii). Later, sagebrush, with climax perennial grasses, became established and dominated the area. Following disturbance from fire, Great Basin sagebrush does not resprout from root crowns but species of Chrysothamnus, Prunus, Ribes, Tetradymia and some Purshia do sprout back. These resprouting species dominate burned areas for up to 20 years after the occurrence of fire (Young and Evans, 1974). In communities where a high density of alien annual grasses, such as cheatgrass (Bromus tectorum), has become established, the reestablishment of sagebrush is inhibited due to frequently recurring fires (Young and Evans, 1978).

Robertson and others (1966) in a field study located in the eastern foothills of the Santa Rosa Mountains in north-central Nevada, found that Great Basin sagebrush reinvaded grubbed areas if the competition from seeded grasses was low. Brush reinvasion into 9-ft cleared strips was more rapid than reinvasion into 1 acre cleared plots. The percent cover of sagebrush in areas cleared 17 years ago was found to range from 0 to 26.5, depending upon amount of competition from grass species.

In a study reported by Young and Evans (1973), the brush overstory, which was dominated by Great Basin sagebrush, was cleared by hand and the recovery of the vegetation was monitored. Alien annual herbs, including Russian thistle, were the initial dominants on sites where a seed source for these species was available. Dominance by downy brome caused a marked reduction in the frequency of native annuals. When downy brome was seeded, relatively dense populations excluded perennial grass seedlings. Sagebrush reestablishment, which was thought to result from a large number of seeds in the soil, was not inhibited by dense growth of downy brome.

Jaynes and Harper (1978) examined the vegetation which colonized 21 study sites along roadways through shadscale-grass, blackbrush, sagebrush and grassland-

shrub communities. The most successful recolonizer of the upper benchlands, which have sandy loam soils, were Indian mountain-rice, James' galleta grass, broom snakeweed, and native annual herbs. On the lower benchlands, which have sandy clay loam soils, shadscale shrubs, desert molly, and other native annuals were found to be successful recolonizers of the roadsides. These studies on Great Basin sagebrush community succession suggest that recovery of this vegetation type to predisturbance density, diversity, and productivity levels will take a minimum of several decades.

In sagebrush communities, grazing has reduced or eliminated the perennial grasses, and changed the shrub composition in many ways. Shrubs that are least preferred for grazing, including the dominant species of Artemisia, have increased in dominance, while preferred forage species have become less common. Introduced annuals such as Russian thistle (Salsola iberica), tumbling mustard (Sisymbrium altissimum) and cheatgrass (Bromus tectorum), are now so widespread, and form such a complete understory in many degraded communities, that reestablishment of native perennial grasses is often precluded (Young and Evans, 1973), and fire behavior and secondary succession altered (Young et al., 1976; Young and Evans, 1978). Without additional disturbance, Russian thistle will be gradually replaced by sagebrush on many of these higher elevation sites (Holmgren and Hutchings, 1972). Similar patterns have resulted from past overgrazing of the other vegetation communities in the potentially impacted valleys.

Pinyon-Juniper Woodland. Pinyon-juniper woodland is widespread in the central and northern parts of the project area, in mountainous terrain, and on high plateaus between 5,000 and 8,000 ft. It occurs in areas that will be directly impacted by the project. This type of forest vegetation occupies more area in the project region than all other forest types combined. The lower elevation limits of its range are determined by amount of precipitation. It generally does not occur in areas that receive less than 12 in. of precipitation annually (Cronquist et al, 1972). The areas in which it occurs receive between 12 and 18 in. of precipitation annually, mostly as snow in winter.

Pinyon-juniper woodland is a community of small evergreen trees, rarely exceeding 20-30 ft in height, and spaced widely enough that the canopies of the trees usually do not touch. There is a moderate to very dense understory of medium-sized shrubs, composed mainly of species characteristic of the Great Basin sagebrush community, especially Great Basin or big sagebrush (Artemisia tridentata). The understory also contains many perennial herbs and grasses, and a limited number of annual herbs and grasses (Cronquist et al., 1972). This vegetation has been called a pygmy forest by various authors (Cottam, 1929; Tanner and Hayward, 1934; Rasmussen, 1941; Woodbury, 1947), but should not be confused with the pygmy forests of the eastern and western coastal regions, which are dominated by conifers stunted as a result of growth in hardpan or saturated soils (Raven, 1977).

The dominant species of this vegetation vary locally with characteristics of topography, elevation, and geographic location. At the lowest elevations, junipers usually dominate alone, often forming extensive juniper woodlands with Great Basin sagebrush understory. At higher elevations, with slightly higher precipitation, pinyons and junipers are intermixed. Some areas, often at the upper elevational limits, are dominated solely by pinyons, although this type of association covers less area than the juniper community (Cronquist et al., 1972).

The most common species of juniper throughout the study area is Utah juniper (Juniperus osteosperma). Rocky mountain juniper (Juniperus scopulorum) occurs in the eastern part of the study area along streams and in dry washes within the elevational range of pinyon-juniper woodland. This species does not form a conspicuous part of the woodland proper and extends to higher elevations and into moister habitats. Singleleaf, or one-needle pinyon (Pinus monophylla), is the most common pinyon of the study area and the Great Basin in general. It is replaced by Pinus edulis in the eastern mountain ranges bordering the study area (Cronquist et al., 1972).

The species lists below are based on current literature and field studies conducted for this report. The shrub layer of the pinyon-juniper woodland commonly contains the following species:

Scientific Name	Common Name
Acer glabrum	Mountain maple
Amelanchier alnifolia	Service-berry
Artemisia arbuscula	Dwarf sagebrush
A. nova	Black sagebrush
A. tridentata	Great Basin sagebrush
Ceanothus velutinus	Tobacco brush
Cercocarpus ledifolius	Narrow-leaved mountain mahogany
Chrysothamnus nauseosus	Rubber rabbitbrush
C. viscidiflorus	Sticky-leaved rabbitbrush
Cowania mexicana var. stansburiana	Cliff rose
Ephedra viridis	Mormon tea
Gutierrezia sarothrae	Matchweed
Holodiscus dumosus	Bitterbrush
Quercus gambelii	Rocky mountain oak
Ribes cereum	Squaw currant
R. velutinum	Gooseberry
Sambucus racemosa	Elderberry
Symphoricarpos oreophilus	Mountain snowberry
Tetradymia canescens	Spineless horsebrush

Common grasses and herbs of this community include:

Scientific Name	Common Name
Achillea millefolium var. lanulosa	Yarrow milfoil
Agropyron smithii	Western wheatgrass
A. spicatum	Bluebunch wheatgrass
Astragalus spp.	Locoweed, rattlepod, milk-vetch species
Balsamorhiza sagittata	Arrow-leaved balsamroot
Bouteloua gracilis	Blue grama
Chrysopsis villosa	Hairy golden-aster
Erigeron spp.	Fleabane species
Erigonum heracleoides	Parsnip-flowered wild buckwheat

E. microthecum	Great Basin buckwheat brush
E. umbellatum	Sulphur buckwheat
Eriophyllum lanatum	Common woolly-sunflower
Festuca idahoensis	Idaho fescue
Frasera albomarginata	Desert frasera
Grindelia squarrosa	Resin-weed
Hymenoxys richardsonii	Hymenoxys
Ipomopsis aggregata	Scarlet gilia
Koeleria cristata	Junegrass
Leucopoa kingii	Spikegrass
Lithospermum ruderale	Columbia puccoon
Lupinus sericeus	Silky lupine
Oryzopsis hymenoides	Indian mountain-rice
Penstemon eatonii	Eaton's firecracker
P. speciosus	Showy penstemon
P. watsonii	Watson's penstemon
Poa fendleriana	Mutton grass
P. sandbergii	Sandberg bluegrass
Sitanion hystrix	Squirreltail
Sporobolus cryptandrus	Sand dropseed
Stipa columbiana	Columbia needlegrass
S. comata	Needle-and-thread grass
S. thurberiana	Thurber needlegrass

The economic importance of this community is limited, but fairly diverse. The wood of pinyons and junipers is not abundant enough, nor of the quality required, for large-scale commercial timber operations. However, this wood is used for fence posts and firewood. Permits are issued near Christmas time by the BLM for harvesting of juniper "Christmas trees" (Hunt and Bishop, 1966). Pinyon pines produce edible pine nuts that are commercially harvested in some areas, often by Native American tribes that traditionally used them as a major food source. The single-leaved pinyon (Pinus monophylla) is recognized in the Nevada Revised Statutes (527.240) as the official state tree; mechanically harvesting these nuts in Nevada is prohibited (NRS 527.250). Pinyon-juniper woodland supports deer, pronghorn antelope, and several species of game birds which are hunted, thus providing revenue through the sale of licenses issued by the state. Agriculture is not practiced in this community, but grazing is fairly widespread (Clary, 1975; Springfield, 1975). In many areas, especially on plateaus and high bajadas, the junipers are removed by chaining or defoliant spraying to increase the growth of more palatable shrubs and grasses. In some cases, seeding with crested wheatgrass (Agropyron spicatum) has been used to increase grazing capacity.

Sources of present disturbance to this community include activities associated with grazing, including chaining and defoliant spraying, and vegetation removal resulting from mining and processing operations, including strip mining and smelting. Airborne pollutants from smelting plants may deteriorate vegetation in a large radius around the smelter (Benedict, 1970). Off-road vehicle scars may be noted in some areas, but this is not yet a major source of disturbance in this community. Natural and man-caused fires are of frequent occurrence.

Limited information is available on the nature of succession in the pinyon-juniper woodland community (West et al., 1975). Under pristine conditions fires

were fairly frequent and secondary succession involving sagebrush establishment followed by pinyon and juniper reestablishment occurred relatively often (Barney and Freschknecht, 1974). The invasion of sagebrush communities by pinyons and junipers in recent times has been investigated by several authors (Blackburn and Tueller, 1970; Burkhardt and Tisdale, 1976; Tausch et al., 1980). In east-central Nevada, junipers and, later, pinyons invade black sagebrush (Artemisia nova) communities until the understory is almost completely eliminated. Accelerated invasion by pinyon and juniper began in about 1921 and is related to overgrazing, fire suppression and climatic change (Blackburn and Tueller, 1970). Similar patterns of tree establishment and understory suppression, beginning as early as the 1870s, have been observed in many areas of the Great Basin (Tausch et al., 1980).

Unique Vegetation: The vegetation types described above are generally common and widespread in the Great Basin. Included in a separate technical report (ETR 17) are descriptions of rare, threatened, or endangered plants, and their habitats. Some vegetative features are not actually rare or threatened, nor are they common or widespread enough to be considered under general vegetation types. These features are defined as unique vegetation; they are atypical, unusual, or in some way unique. Examples are as follows:

1. Range extensions: Areas where a certain species reaches the limit of its range, or occurs as a disjunct population. For example, regions where the Joshua tree reaches the northernmost extent of its geographic distribution.

2. Relict populations: Areas in the Great Basin, usually at high elevations, where a certain species or group has remained unaltered for long periods of time. They are the remaining populations of plant species whose distributions were once more widespread. Boreal forests consisting of ponderosa pine (Pinus ponderosa) and bristlecone pine (Pinus longaeva) are examples.

3. Unusual ecotypes: Areas where, for unknown reasons, plants occur in a habitat that is radically different from the normal habitat associated with that plant. For example, an occurrence of Rocky Mountain juniper (Juniperus scopulorum) in a low marshy zone.

4. Hybridization zones: Areas where biological species are intergrading and undergoing "explosive evolution" (experiencing rapid rates of change). These areas are considered unique if they are currently being studied or have been clearly identified.

5. Aquatic or wetland vegetation: Areas where riparian, marsh, or distinctive spring vegetation are known to occur. These areas are not common in the Great Basin and are considered unique only if verified by field data or if documented in the literature.

6. Bald Mountains: Mountains or peaks which contain a sagebrush-grass zone at the summit, above the pinyon-juniper zone. In these areas it appears that pinyon-juniper vegetation is superimposed upon a large sagebrush-grass zone which has wide elevational tolerances (Billings, 1951).

7. Joshua tree zones: Areas in which Joshua tree (Yucca brevifolia) is known to occur. The limited distribution of this plant association within the project area includes the northernmost populations of the Joshua tree.

8. Alpine or sub-alpine vegetation: Treeless areas at high elevations; known only from a few mountain ranges such as the Deep Creek and Snake ranges.

9. Sand dune vegetation: Species that occur here are often substantially different from those of the surrounding community. (Stutz et al., 1975).

Table 2 lists valleys in the project area which contain unique vegetation features.

Timber Resources: Nevada's total forest land amounts to 7.7 million acres. Only 129,000 acres of this total is estimated as commercial timberland. None of the counties from which timber production is reported are within the deployment area boundaries.

In contrast to Nevada, forest products in Utah are an important part of its economy. In Utah, the national forests rim the M-X deployment area to the east and south, and no portion of them is within geotechnically suitable land.

Approximately 29 percent of the land area of Utah has been classified as forest, one fourth of the total is commercially valuable for timber production. (Table 3 presents the geographic distribution of the acreage.) Under multiple-use programs, this land serves watershec' and recreational needs, provides vast quantities of forage for both livestock and game animals.

Commercial saw-timber species produced in Utah are Ponderosa pine, white fir, Douglas fir, Engelmann spruce, sub-alpine fir, lodgepole pine, and aspen. The non-commercial forest areas are mostly covered by pinyon and juniper, which are sometimes used for firewood, posts, and Christmas trees.

VEGETATION - TEXAS/NEW MEXICO

The Texas/New Mexico Alternative Siting Region lies almost entirely within the Texas/New Mexico High Plains, also known as the Llano Estacado or Staked Plains: a high, flat to gently rolling plateau area which is a southern extension of the Great Plains. The vegetation is classified as mixed prairie or short-grass prairie depending on the author (Correll and Johnston, 1970; Rowell, 1967; Weaver and Albertson, 1956). A general vegetation map for the Texas/New Mexico siting region is in Figure 3. Some common plants of the deployment area are listed in Table 4. Historically, the Llano was dominated by perennial grasses of low diversity in association with forbs of higher diversity, but low cover. In southeastern New Mexico, species characteristic of the Great Plains are partially replaced by species of desert grasslands, interspersed with patches of Chihuahuan Desert scrub. Pinyon (Pinus edulis) and juniper (Juniperus spp.) woodland intrude into the area from the north (U.S. Soil Conservation Service, 1977b).

Table 2. Unique vegetation features of the Nevada/Utah study area, (Page 1 of 4).

HYDROLOGIC SUBUNIT		REGION NAME	UNIQUE OR UNUSUAL OCCURRENCE
(U) 3	<u>Deep Creek</u>*	Deep Creek Mountains	Alpine and subalpine vegetation; many range extensions; boreal forests[1] linked with southern mountains. Riparian vegetation.[2]
(U) 4	<u>Snake</u>	Mount Moriah Wheeler Peak Deep Creek Mountains	Alpine tundra vegetation. Alpine tundra; boreal forest (extensive bristlecone pine)[2] Boreal forests; riparian vegetation.
(U) 5	<u>Pine</u>	Desert Range R.N.A.	Scientific study of grazing effects on vegetation.[3]
(U) 7	<u>Fish Springs</u>	Fish Springs N.W.R.	Marsh vegetation.
(N) 24	Hualapai Flat	Granite Range	Bald mountain; no junipers, pinyon pines.
(N) 28	Black Rock Desert	Granite Range	Bald mountains.
(U) 32B	Great Salt Lake Desert-West	Deep Creek Mountains	Boreal forests (see U 3)
(N) 45	Lamoille Valley	Ruby Mountains Lamoille Canyon	Extensive alpine tundra; *Pinus albicaulis;* occurrence of *Selaginella* sp.[4]
(N) 46	Lamoille Valley	Ruby Mountains	Extensive alpine tundra.
(U) 46	<u>Sevier Desert</u>		Sand dune vegetation. Unusual population of four-wing saltbush (*Atriplex canescens*)[5]
(N) 53	<u>Pine</u>	Roberts Mountains	"Unusually" lush vegetation-bristlecone pine.
(N) 54	<u>Crescent</u>	Beowawe Geysers	Sinter terrace colonized by *Poa nevadensis* (Nevada bluegrass).
56	<u>Upper Reese</u>	Toiyabe Dome	Riparian vegetation; boreal-limber pine; alpine tundra.[2]
58	<u>Middle Reese</u>		Riparian vegetation.[2]
60	Whirlwind	Beowawe Geysers	Riparian vegetation.
70	Winnemucca	Water Canyon Winnemucca Sand Dunes	Riparian-questionable purity. Possible unique vegetation on dunes.
81	Pyramid Lake	Pah Rah Range	*P. ponderosa, P. jeffreyi.*[4]
82	Dodge Flat	Pah Rah Range	*P. ponderosa, P. jeffreyi.*[4]
83	Tracy Segment	Virginia Mountains	*P. ponderosa, P. jeffreyi, P. monticola.*[4]
84	Warm Springs	Virginia Mountains	*P. ponderosa, P. jeffreyi, P. monticola.*[4]
87	Truckee Meadows		Sand dune and riparian vegetation; hot springs vegetation.[2]
88	Pleasant		Hot springs vegetation.[2]
89	Washoe	Washoe Lake Dunes	Sand dune vegetation.

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Table 2. Unique vegetation features of the Nevada/Utah study area, (Page 2 of 4).

HYDROLOGIC SUBUNIT		REGION NAME	UNIQUE OR UNUSUAL OCCURRENCE
103	Dayton	Carson Plains Dunes	Sand dune vegetation.
104	Eagle	Carson Valley	Sand dune and riparian vegetation.
105	Carson	Carter Spring	Lush Pinyon-juniper community; relatively protected. *P. jeffreyi*.
108	Mason	Wassuck Range	*P. jeffreyi*
109		Wassuck Range	*P. jeffreyi*
110A,B,&C	Walker Lake	Mount Grant Walker Lake	Bald Mountain; serpentine area. Riparian vegetation.
137	Big Smokey		*Atriplex* hybridizations.[9] Riparian vegetation (137B)[12]
139	Kobeh	Roberts Mountains	Bristlecone pine.
140B	Monitor	Mount Jefferson	*Atriplex* hybridizations (valley bottom);[9] boreal forests; limber pine, bristlecone pine; USFS Alpine vegetation research area.
141	Ralston		*Atriplex* hybridizations.[9]
142	Alkali Springs	Goldfield Joshua Grove	Northern extension of Joshua Tree.
143	Clayton	Pinyon-Joshua Transition Silver Peak Range	*Pinus/Yucca* transition zone. Bristlecone pines.
144	Lida Valley	Goldfield Joshua Grove	Northern extension of Joshua Tree.
146	Sarcobatus Flat	Sarcobatus Flat	Most extensive pure stand (12 miles) of greasewood.
150	Little Fish Lake	Hot Creek Range and Valley	Study site for shadscale community.
153	Diamond	Roberts Mountains	Boreal forests-limber pine.
155C	Little Smokey South	Lunar Crater	Unusual dominance of *Sphaeralcea* on undisturbed sites.
156	Hot Creek	Morey Peak Hot Creek Range and Valley Hicks Station	*Cowania* hybrid with *Purshia tridentata*;[3] relict plants-bristlecone pine on volcanic soil[6] Study site for shadscale. Wet meadow-native?
158A,B	Emigrant	Desert N.W.R.	Bristlecone pine, Joshua tree.
160	Frenchman Flat	Desert N.W.R.	Bristlecone pine, Joshua tree.
161	Indian Springs	Desert N.W.R. Mount Stirling	Bristlecone pine, Joshua tree. Wood Canyon: U.N.L.V. rates as exceptional botanical area.

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Table 2. Unique vegetation features of the Nevada/Utah study area, (Page 3 of 4).

HYDROLOGIC SUBUNIT		REGION NAME	UNIQUE OR UNUSUAL OCCURRENCE
162	Pahrump	Mount Stirling Carpenter Canyon	Wood Canyon: U.N.L.V. rates as exceptional botanical area. Bristlecone pine, relict populations.
168	Three Lakes	Desert N.W.R.	Bristlecone pine, Joshua tree.
169A,B	Tickaboo	Desert N.W.R.	Bristlecone, Joshua tree.
172	Garden Valley	(Inside National Forest boundary) Troy Peak	Unusual cliffrose forest (1,000 acres, plants 8-12 ft high, almost a pure stand; located on a site which would ordinarily be expected to be occupied by juniper; Bristlecone pines.
173	Railroad-South	Troy Peak	Bristlecone pines.
173B	Railroad-North	Duckwater	Riparian-*Utricularia* present.
176	Ruby Valley	Ruby Mountains Ruby Lake	Extensive alpine tundra. Wetland vegetation.
178A	Butte Valley	Spruce Mountain	Northern extension of bristlecone.[4]
178B	Butte	Heusser Mountain Bristlecone Pine N.A. (420 acres)	Bristlecone pines.
179	Steptoe	Heusser Mountain Bristlecone Pine N.A.	Bristlecone pines, riparian vegetation.
180	Cave	Mt. Grafton	Bristlecone pine, white fir (*Abies concolor*) No botanical study.
181	Dry Lake Valley	Highland Range (i.e.) southern bajadas	Ponderosa pine-all age classes; pure, extensive stands of Mountain mahogany (*Cercocarpus ledifolius*) Occurrence of Joshua tree (*Yucca brevifolia*).
182	Delamar	Delamar Mountains-western edge	*Yucca brevifolia* occurrence.
183	Lake Valley	Mt. Grafton	Bristlecone pine, white fir, no botanical study.
184	Spring Valley	Mount Moriah Shoshone Pygmy Sage N.A. Swamp Cedar N.A.	Alpine tundra Pygmy sage (*Artemisia pygmaea*)[3] Swamp cedars.
187	Goshute	Spruce Mountain	Northern extent of bristlecone pine.
194	Pleasant	Kern Mountain	Unique ecotones associated with unusual geology-limber pine to near canyon floor; BLM scenic area.[2]
196	Hamlin	Wheeler Peak	Alpine tundra; boreal forests.
198	Dry Valley	Gleason Canyon	Relict ponderosa pine.
202	Patterson Wash	Highland Range	Ponderosa pine, all age classes; purest and most extensive stands of Mountain mahogany (*Cercocarpus*).
203	Panaca Valley	Highland Range	Ponderosa pine, all age classes; purest and most extensive stands of *Cercocarpus*.

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Table 2. Unique vegetation features of the Nevada/Utah study area, (Page 4 of 4).

HYDROLOGIC SUBUNIT		REGION NAME	UNIQUE OR UNUSUAL OCCURRENCE
205	Meadow Valley Wash		Riparian vegetation.
207	White River Valley	Troy Peak Wayne-Kirch Wildlife Area Hot Creek Springs and Marsh	Bristlecone Pine. Marsh vegetation. Riparian-marsh vegetation; gypsum mounds.
209	Pahranagat	Pahranagat N.W.R.	Joshua tree? Riparian vegetation.
210	Coyote Springs	D. N.W.R. Hayford Peak[6]	Bristlecone pine: Joshua tree, on east slope of Sheep Range. Bristlecone (2,000 acres)[11]
211	Three Lakes	D. N.W.R.	Bristlecone pine Joshua tree.
212	Las Vegas	D. N.W.R.	Bristlecone pine. Joshua tree.
222	Virgin River	Virgin River Virgin Mountains	Riparian vegetation. Southern extent of Douglas fir; relicts.
223	Gold Butte	Virgin Mountains	Southern extent of Douglas fir; relicts.
225	Mercury	Mount Stirling	Wood Canyon; U.N.L.V. considers this an exceptional botanical area.
230	Amargosa Desert	Mount Stirling	Wood Canyon; U.N.L.V. Considers this an exceptional botanical area.

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*Valleys which are underlined are within project area.

[1]Boreal forests include: Bristlecone pine (*Pinus longaeva*), ponderosa pine (*Pinus ponderosa*).

[2]Tausch, R., 1980. Personal communication.

[3]Bostick, V. B. and W. E. Niles, et al., 1975.

[4]Conquist, A., A. H. Holmgren, N. H. Holmgren, and J. L. Reveal, 1972. "Intermountain Flora," Volume I. Columbia University Press, New York.

[5]Stutz, H. C., J. M. Melby, and G. K. Livingston, 1975. "Evolutionary Studies of *Atriplex canescens*," Amer. J. Bot. 62(3): pp. 236-245.

[6]Van Pelt, Nicholas, 1980. Telephone communication.

[7]Billings, W. D., 1949. "The Shadscale Vegetation Zone of Nevada and Eastern California in Relation to Climate and Soils," American Midland Naturalist, Vol. 42, pp. 87-109.

[8]Nord, E. C., 1965. "Autecology of Bitterbrush in California," Ecological Monographs, Vol. 35, #3, pp. 307-334.

[9]U.S.D.I., Bureau of Land Management, 1980. "Shoshone Pygmy Sage Natural Area," Wilderness Report, Nevada State Office.

[10]U.S.D.I., Bureau of Land Management, 1980. "Swamp Cedar Natural Area," Wilderness Report, Nevada State Office.

[11]Federal Committee of Research Natural Areas, 1968. "A Directory of Research Natural Areas on Federal Lands of the U.S." U.S. Government Printing Office, Washington, D.C.

[12]Linsdale, Mary A., J. T. Howell, and J. M. Linsdale, 1952. "Plants of the Toiyabe Mountains Area, Nevada," Wasmann Journal of Biology, Vol. 10, #2.

Table 3. Area in national forests in Utah - 1978.

FOREST	NUMBER OF ACRES (X000)
Ashley	1,288
Dixie	1,884
Fishlake	1,424
Manti-LaSal	1,238
Uintah	813
Wasatch	1,265
Sawtooth	71
Caribou	7
State Total	7,990

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Source: U.S. Forest Service, Lands Division (Regional Office, Ogden, Utah), 1978.

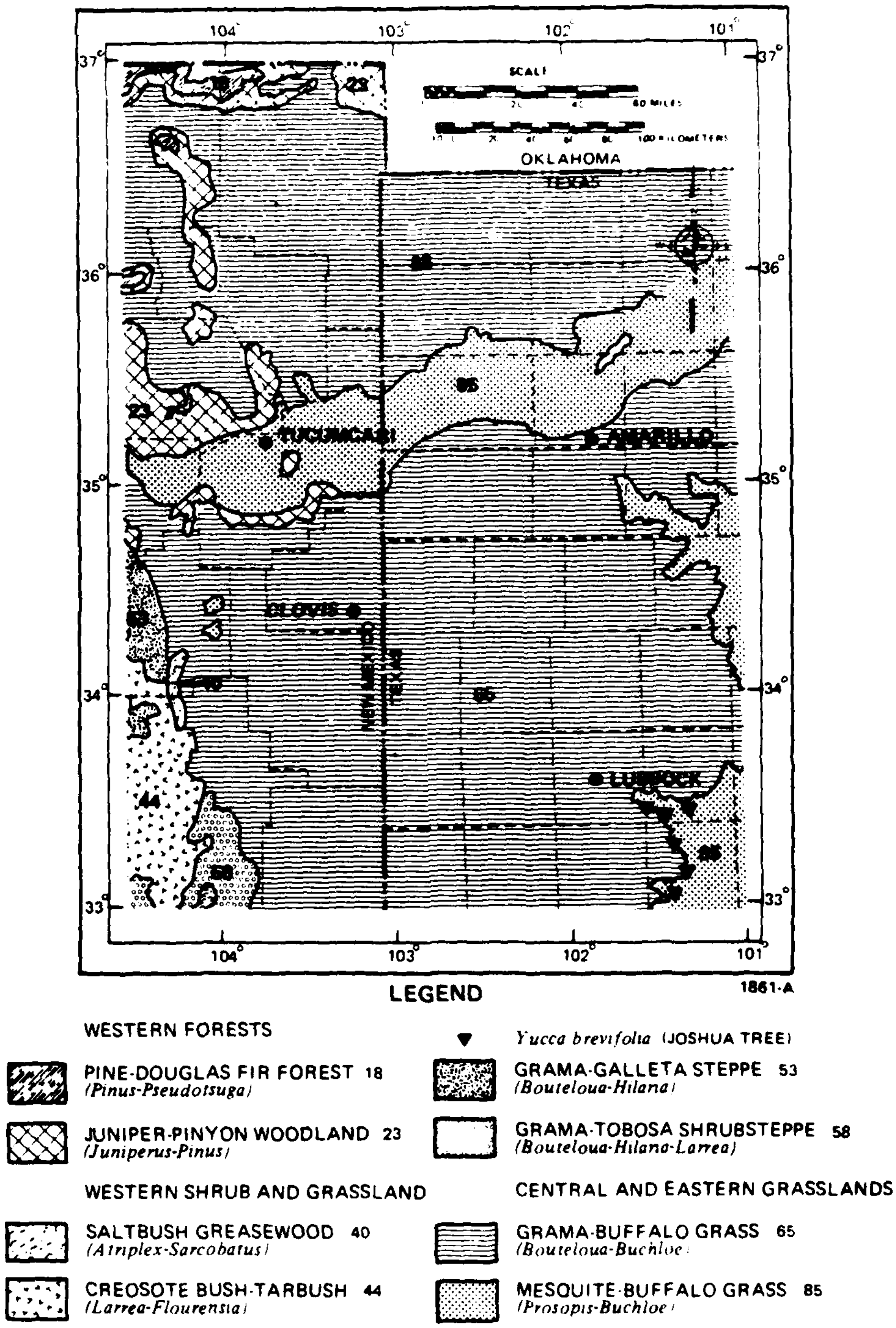

Figure 3. Natural vegetation of the Texas/New Mexico study area (Kuchler, 1975).

Table 4. Some common native and naturalized plants of the Texas/New Mexico study area[1] (Pg 1 of 2).

SCIENTIFIC NAME	COMMON NAME	VEGETATION TYPE[2]	HABIT[3]	NATIVE (N) INTRODUCED (I)
Acacia greggii	Catclaw acacia	UCB,MG	S	N
Agropyron smithii	Western wheatgrass	PLW,RW,BGG	PG	N
Andropogon hallii	Sand bluestem	UCB,SDV,BG	PG	N
A. scoparius	Little bluestem	UCB,DG,SDV, MG,BG,MGG	PG	N
Ambrosia psilostachya	Western ragweed	MGG,BGG	PH	N
Aristida purpurea	Purple three-awn	BG,MGG	PG	N
Artemisia filifolia	Sand sage	SDV,BG	S	N
Bouteloua breviseta	Gyp grama	DG	PG	N
B. curtipendula	Side-oats grama	PLW,UCB,SDV, BG,MGG,BGG	PG	N
B. eriopoda	Black grama	DG,MG,CDS, MGG	PG	N
B. gracilis	Blue grama	DG,MG,BG UCB,MGG,BGG	PG	N
B. hirsuta	Hairy gramma	BG,MGG	PG	N
Buchloe dactyloides	Buffalo grass	PLW,MG,BGG	PG	N
Calamovilfa gigantea	Big sandreed	SDV	PG	N
Celtis retriculata	Western hackberry	UCB,RW	T/S	N
Condalia spp.	Condalia	CDS	S	N
C. ericoides	Javelina bush	CDS	S	N
Croton texensis	Texas croton	MGG	AH	N
Distichlis spicata	Inland saltgrass	PLW	PG	N
Echinochloa crusgalli	Barnyard grass	PLW	AG	N
Eleocharis spp.	Spikerush	RW,PLW	AH/PH	N
Elymus canadensis	Canadian wild-rye	BG	PG	N
Erioneuron pulchellum	Fluff grass	DG	PG	N
Guttierrezia sarothrae	Matchweed	CDS	S	N
Hilaria jamesii	James' galleta grass	PLW,BGG	PG	N
H. mutica	Tabosa grass	PLW,DG,MG, FV,CDS,BGG	PG	N
Juncus spp.	Rush	PLW,RW	AH/PH	N
Juniperus spp.	Juniper	UCB	T/S	N
Koeberlinia spinosa	Allthorn	CDS	S	N
Krameria spp.	Ratany	CDS	S/PH	N
Larrea tridentata	Creosote bush	CDS	S	N
Muhlengergia porteri	Bush munly	CDS	PG	N
Panicum spp.	Wild duck millet	PLW	A/PG	N
P. obtusum	Vine-mesquite grass	FV,RW	PG	N
P. virgatum	Switch grass	RW,SDV	PG	N
Phalaris caroliniana	Canary grass	PLW	AG	N
Pinus edulis	Pinyon	UCB	T	N
Populus spp.	Cottonwood	RW	T	N/I
Prosopis juliflora	Honey mesquite	FV,RW,DG	T/S	N
Potamogeton spp.	Pond weed	PLW	A/PH	N
Prunus virginiana	Chokecherry	UCB	S/T	N
Psoralea linearifolia	Slimleaf scurfpea	BGG	PH	N

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Table 4. Some common native and naturalized plants of the Texas/New Mexico study area[1] (Pg 2 of 2).

SCIENTIFIC NAME	COMMON NAME	VEGETATION TYPE[2]	HABIT[3]	NATIVE (N) INTRODUCED (I)
P. tenu	Scurfy pea	MGG	PH	N
Quercus spp.	Oak	UCB	T/S	N
Q. havardii	Shinnery oak	SDV, BG	T/S	N
Rhus aromatica	Skunkbush sumac	UCB	S	N
R. microphylla	Small-leaved sumac	CDS	S	N
Salix spp.	Willow	PLW, RW	T/S	N
Schedonnardus paniculatus	Tumblegrass	BG, MGG, BGG	PG	N
Scirpus spp.	Spikerushes	PLW	PH	N
Sorghastrum nutans	Indian grass	SDV, BG	PG	N
Sphaeralcea coccinea	Scarlet globemallow	BGG	PH	N
Sporobolus airoides	Alkali sacaton	FV	PG	N
S. cryptandrus	Sand dropseed	SDV, BGG, BGG	PG	N
S. giganteus	Giant dropseed	FV	PG	N
Tamarix spp.	Salt cedar, Tamarisk	PLW, FV, RW	T/S	I
Typha domingensis	Cattails	PLW	PH	N
Yucca spp.	Yucca	MG	T/S	N
Yucca elata	Soap-tree yucca	DG	T/S	N
Yucca glauca	Small soapweed	BG	T/S	N
Ziziphus obtusifolia	Lotebush	RW	T/S	N

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[1] This list does not include any rare and/or endangered plant taxa.

[2] BGG = Blue Grama Grassland; MGG = Mixed Grama Grassland; BG = Bluestem Grassland; MG = Mesquite Grassland; SDV - Sand Dune Vegetation; DG = Desert Grassland; UCB = Upland and Canyon Break Vegetation; RW = Riparian Woodland; FV - Floodplain Vegetation; PLW = Playa Lake Wetland, CDS = Chihuahuan Desert Scrub

[3] T = tree; S = shrub; PH = perennial herb; AH = annual herb; PG = perennial grass; AG = annual grass; BH = biennial herb.

Although historically most of the siting region was in grassland, today much of the area is under cultivation. The largest area in the Texas portion of the study area remaining in native vegetation lies along the Canadian Breaks, the canyon lands and floodplains of the Canadian River. Other more or less natural areas occur in Palo Duro Canyon in Randall County, Texas, and around some of the many playa lakes and pot holes characteristic of the Llano. In general, native vegetation remains where land is unsuitable for cultivation, such as along washes and streams, around playas, and in very sandy soil. Patches of non-cultivated land occur throughout the Texas portion of the siting area and are used primarily as range or pasture for livestock. Most of the suitable land is planted in crops such as wheat, sorghum, and cotton. Cultivation is most intense in Castro and Parmer counties, where less than 5 percent of the land remains in natural vegetation, and least intense in counties along the Canadian Breaks, particularly Oldham County, where about 85 percent of the land remains as rangeland (Texas Game and Fish, 1980). In the southern part of Cochran County, Texas (and also in southeastern New Mexico) large tracks of native vegetation remain in oil fields. Here small areas of disturbance mark the landscape around oil rigs.

Cultivation is much less intense in the New Mexico portion of the study area. (U.S.D.A. Soil Conservation Service, 1977a,b,c, 1978, 1980). Much of the farmland occurs in Curry County which has only about 15 percent of its area remaining in natural vegetation. Roosevelt County and, to a lesser extent, Quay County also contain large areas of farmland although this constitutes less than one-third of the total areas of either county (U.S.D.A. Soil Conservation Service, 1977c). Other parcels of cultivated land occur throughout the New Mexico portion of the siting region. Much of the rangeland of the High Plains and desert grassland has a history of extreme overgrazing (York and Dick-Peddie, 1969) dating back to the late 19th century.

As a result of overgrazing, the redistribution of water to supply cattle, and the decrease in range fires which kill seedling shrubs, woody plants, particularly honey mesquite (Prosopis juliflora), have invaded many rangeland areas. Historically, shrubs and trees were largely confined to watercourses and canyon breaks. Honey mesquite is the most common rangeland invader. Juniper (Juniperus spp.) has spread out of the canyon breaks to the north and shinnery oak (Quercus havardii) is a common invader in sandy areas to the south. Areas in southeastern New Mexico that are now classified as Chihuahuan desert shrub are thought to have been covered by desert grassland 150 years ago (York and Dick-Peddie, 1969). Creosote bush (Larrea tridentata), the dominant shrub in these areas, is believed to have spread from gravelly hilltops which are less suitable for grass (York and Dick-Peddie, 1969). Other common invaders throughout the siting region include yucca (Yucca spp.), sand sage (Artemisia filifolia), and matchweed (Gutierrezia sarothrae), as well as less palatable grasses such as sand dropseed (Sporobolus cryptandrus) and tumblegrass (Schedonnardus paniculatus).

Eleven vegetation types are included in this report as characteristic of the siting region today (excluding farm and urban areas). Table 5 lists the major vegetation types in the Texas/New Mexico study area, along with their general location, composition, and sources of present disturbance. These are based on a compilation of vegetation data from a variety of sources including BLM and the Soil Conservation Service in New Mexico, the Texas Natural Resources Information System, the Texas Parks and Wildlife Department, and the Texas Bureau of

Table 5. Major vegetation types in the Texas/New Mexico study area.

TYPE	GENERAL LOCATION	COMPOSITION	SOURCE OF PRESENT DISTURBANCE
Blue grama grassland	Clay-clay loam soils, north-northeast portions	Blue grama, buffalo grass	Agriculture, grazing
Mixed grama grassland	Silt loam-sandy loam, most of high plains	Blue grama, side-oats grama, purple three-awn	Agriculture, grazing
Bluestem grassland	Sandy soils	Little bluestem, side-oats grama, sand bluestem, sand sage, shinnery oak	Grazing, agriculture, oil fields
Mesquite grassland	Overgrazed grassland	Honey mesquite, blue grama, little bluestem	Overgrazing, ORVs
Sand dune vegetation	Sand	Shinnery oak, sand sage	Grazing, hunting, ORVs
Desert grassland	Western edge, dry high plains	Black grama, tobosa grass, fluff grass, soap-tree yucca	Grazing, hunting, ORVs
Chihuahuan Desert scrub	Southern edge, high plains	Creosote bush, black grama, bush muhly	Grazing, hunting, ORVs
Upland and canyon break vegetation	Gravelly loam, rolling to steep slopes	Juniper, mesquite, oak	Grazing, hunting, ORVs
Riparian woodland	Stream valleys	Cottonwood, hackberry, willows, mesquite, tamarisk	Hunting, grazing, camping, ORVs
Floodplain vegetation	Salty floodplains	Alkali saccaton, giant dropseed	Grazing, ORVs
Playa lake wetland	Playa lakes on high plains, clay soils	Buffalo grass, wheatgrass, cattail, bullrush, willow	Agriculture, grazing

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Economic Geology. The following vegetation types, and a section on timber resources, are briefly described below:

- Blue Grama Grassland
- Mixed Grama Grassland
- Bluestem Grassland
- Mesquite Grassland
- Sand Dune Vegetation
- Desert Grassland
- Upland and Canyon Break Vegetation
- Riparian (Streambank) Woodland
- Floodplain Vegetation
- Playa Lake Wetland
- Chihuahuan Desert Scrub

Blue Grama Grassland: Blue grama grassland occurs primarily in the northern and eastern portions of the siting area, usually on clay to clay loam soils. Because these soils are hard when dry, areas containing them are referred to as the Hardlands (Lotspeich and Everhart, 1967; Correll and Johnston, 1970). Usually two species of grasses, blue grama (*Bouteloua gracilis*) and buffalo grass (*Buchloe dactyloides*), co-dominate. The diversity of grasses is low. Forb diversity is much higher, but the cover of forbs in usually 5 percent or less. Blue grama is dominant on well-managed rangeland while the less palatable buffalo grass, is dominant where grazing is heavy. Western wheatgrass (*Agropyron smithii*) is abundant in areas of New Mexico and around well-managed playa margins in Texas but is replaced by buffalo grass in overgrazed areas. Tobosa grass (*Hilaria mutica*) occurs in the south and James' galleta grass (*Hilaria jamesii*) in the north. A brief species list includes the following:

Blue grama	(*Bouteloua gracilis*)
Buffalo grass	(*Buchloe dactyloides*)
Western wheatgrass	(*Agropyron smithii*)
James' galleta grass	(*Hilaria jamesii*)
Tobosa grass	(*Hilaria mutica*)
Sideoats grama	(*Bouteloua curtipendula*)
Sand dropseed	(*Sporobolus cryptandrus*)
Western ragweed	(*Ambrosia psilostachya*)
Scarlet globemallow	(*Sphaeralcea coccinea*)
Slimleaf scurfpea	(*Psoralea linearifolia*)

Mixed Grama Grassland: Mixed grama grassland occurs throughout the High Plains on silty loam to sandy loam soil. These areas, often referred to as mixed lands, have more favorable water relations than hardland areas. Blue grama may be dominant on individual sites and buffalo grass becomes abundant only where grazing is heavy. Sideoats grama (*Bouteloua curtipendula*) is often co-dominant with blue grama. Western wheatgrass is usually absent. Forb cover, but not diversity, is very low. Black grama (*Bouteloua eriopoda*) increases in importance in the south, particularly in the ecotonal area between the High Plains and desert grassland. Common species of the mixed grama grassland include:

Blue grama	(*Bouteloua gracilis*)
Sideoats grama	(*Bouteloua curtipendula*)

Purple three-awn	(Aristida purpurea)
Sand dropseed	(Sporobolus cryptandrus)
Hairy grama	(Bouteloua hirsuta)
Black grama	(Bouteloua eriopoda)
Little bluestem	(Andropogon scoparius)
Western ragweed	(Ambrosia psilostachya)
Texas croton	(Croton texensis)
Scurfy pea	(Psoralea tenuiflora)

Bluestem Grassland: The bluestem vegetation type occurs on sandy soils throughout the High Plains. Little bluestem (Andropogon scoparius) and sideoats grama (Bouteloua curtipendula) are dominant. The diversity of grasses is usually higher than in the previous two vegetation types. Small shrubby species such as small soapweed (Yucca glauca), sand sage (Artemisia filifolia) and, to the south, shinnery oak (Quercus havardii) occur as invaders. Blue grama and sand dropseed are also increasing in this community. Common species of the bluestem grassland include:

Little bluestem	(Andropogon scoparius)
Sideoats grama	(Bouteloua curtipendula)
Sand bluestem	(Andropogon hallii)
Switch grass	(Panicum virgatum)
Indian grass	(Sorghastrum nutans)
Blue grama	(Bouteloua gracilis)
Canadian wildrye	(Elymus canadensis)
Purple three-awn	(Aristida purpurea)
Sand dropseed	(Sporobolus cryptandrus)
Hairy grama	(Bouteloua hirsuta)
Small soapweed	(Yucca glauca)
Sand sage	(Artemisia filifolia)
Shinnery oak	(Quercus havardii)

Mesquite Grassland. Honey mesquite (Prosopis juliflora) occurs primarily as an invader throughout the siting area. One hundred and fifty years ago the shrub probably occurred, in large stands, only along the Canadian Breaks (Box, 1967), with small stands along other watercourses and around watering holes and Native American campsites (York and Dick-Peddie, 1969). Because this shrub has a tendency to increase with overgrazing, mesquite grassland represents an important plant community type today. Mesquite may share dominance with one or more of the grass species characteristic of the grassland communities or occur in almost pure stands, particularly in the south. Mesquite has relatively high water requirements, and invades areas with sandy soil or areas that receive more than average amounts of moisture. Species commonly found in association with mesquite include:

Blue grama	(Bouteloua gracilis)
Little bluestem	(Andropogon scoparius)
Sand dropseed	(Sporobolus cryptandrus)
Matchweed	(Gutierrezia sarothrae)
Catclaw acacia	(Acacia greggii)
Buffalo grass	(Buchloe dactyloides)
Black grama	(Bouleloua eriopoda)
Tobosa grass	(Hilaria mutica)
Yucca	(Yucca spp.)

Sand Dune Vegetation: Sand dunes occupy only a small proportion of the total area of the siting region. Grass diversity tends to be high on undisturbed stabilized dunes, and forbs make up a significant part of the cover. Sand bluestem (Andropogon hallii) and little bluestem are the most important grasses historically, although invaders like sand dropseed are currently very common. Sand sage and small soapweed are the major shrubs north of Portales, New Mexico, and shinnery oak is common to the south. These shrubs increase with disturbance and replace much of the grass. Major species of the dunes include:

Shinnery oak	(Quercus havardii)
Sand sage	(Artemisia filifolia)
Small soapweed	(Yucca glauca)
Sand bluestem	(Andropogon hallii)
Indian grass	(Sorghastrum nutans)
Switch grass	(Panicum virgatum)
Side-oats grama	(Bouteloua curtipendula)
Sand dropseed	(Sporobolus cryptandrus)
Little bluestem	(Andropogon scoparius)
Big sandreed	(Calamovilfa gigantea)

Desert Grassland: Major species of the desert grassland areas in southeastern New Mexico include black grama, tobosa grass and fluff grass (Erioneuron pulchellum). Much of this area contained elements of the High Plains grassland and may be considered ecotonal between the forementioned community and the desert. Important High Plains grasses include little bluestem and blue grama. Soap-tree yucca (Yucca elata) is common. Following is a list of major species of the desert grassland:

Black grama	(Bouteloua eriopoda)
Tobosa grass	(Hilaria mutica)
Fluff grass	(Erioneuron pulchellum)
Little bluestem	(Andropogon scoparius)
Blue grama	(Bouteloua gracilis)
Soap-tree yucca	(Yucca elata)
Honey mesquite	(Prosopis juliflora)
Gyp grama	(Bouteloua breviseta)

Chihuahuan Desert Scrub. Chihuahuan desert scrub in the study region is found in areas in Chaves and Lea counties, New Mexico. Most of these areas are believed to have been originally in desert grassland. The dominant shrub species is usually creosote bush (Larrea tridentata) which is thought to have been originally confined to rocky, flat hill tops. Matchweed (Gutierrezia sarothrae) is often co-dominant. Black grama, bush muhly (Muhlenbergia porteri), and tobosa grass are common grasses. Mixed shrub communities in the south may contain a number of shrub species in addition to creosote bush. Common plant species include:

Matchweed	(Gutierrezia sarothrae)
Creosote bush	(Larrea tridentata)
Black grama	(Bouteloua eriopoda)
Bush muhly	(Muhlenbergia porteri)

Tobosa grass	(Hilaria mutica)
Javelina bush	(Condalia ericoides)
Small-leaved sumac	(Rhus microphylla)
Allthorn	(Koeberlinia spinosa)
Condalia	(Condalia spp.)
Ratany	(Krameria spp.)

Upland and Canyon Breaks Vegetation: Species of juniper (Juniperus spp.) are the most universally found trees of the uplands and canyon breaks of the High Plains. The soils of these areas tend to be gravelly loam and are sometimes shallow. The terrain varies from steep and rugged to gently rolling, resulting in complex vegetation patterns. Juniper is found in association with many other shrubs, depending on slope, soil type, and elevation. In the lower rolling hills honey mesquite (Prosopis juliflora) is often co-dominant. To the north and west, pinyon (Pinus edulis) shares dominance, and in the Canadian River Canyon of Harding County and extreme northern Union County, New Mexico, there are a few ponderosa pine (Pinus ponderosa). Larger areas of juniper-oak woodland occur in Union County. Common canyon break and upland species include:

Honey mesquite	(Prosopis juliflora)
Juniper	(Juniperus spp., primarily osteosperma and pinchotii)
Pinyon	(Pinus edulis)
Oak	(Quercus spp.)
Chokecherr	(Prunus virginiana)
Western h[illegible]rry	(Celtis reticulata)
Skunkbush sumac	(Rhus aromatica)
Catclaw acacia	(Acacia greggii)
Sand bluestem	(Andropogon hallii)
Little bluestem	(A. scoparius)
Sideoats grama	(Bouteloua curtipendula)
Blue grama	(B. gracilis)

Riparian (Streambank) Woodland: Cottonwoods (Populus spp.) are the only important large native trees along the larger rivers of the siting region, including the Canadian and Red rivers in the north and the Pecos River in the southeast. Other native riparian shrubs and trees include hackberry (Celtis reticulata), willows (Salix spp.), and honey mesquite (Prosopis juliflora). Salt cedar (Tamarix spp.) is abundant in riparian areas throughout the siting region and has a rapidly spreading distribution. It is the only large tree along stretches of the Pecos River. Rushes (Juncus spp.) and sedges (Eleocharis spp.) are common riparian vegetation, and many of the grass species, mentioned previously, occur along the shores. Lotebush (Ziziphus obtusifolia) is common along minor drainage ways. Common riparian woodland species include:

Cottonwoods	(Populus spp.)
Willows	(Salix spp.)
Salt cedar, Tamarisk	(Tamarix spp.)
Hackberry	(Celtis reticulata)
Honey mesquite	(Prosopis juliflora)
Switch grass	(Panicum virgatum)
Vine-mesquite grass	(Panicum obtusum)

Western wheatgrass	(Agropyron smithii)
Lotebush	(Ziziphus obtusifolia)

Floodplain Vegetation: The most common species of the salty floodplains of the Pecos and Canadian rivers are alkali saccaton and giant dropseed (Sporobolus giganteus), which is found in almost pure stands. Tobosa grass (Hilaria mutica) occurs in swales in the south. These grasses also occur on and around playas which flood occasionally. Floodplains which are not excessively salty are often covered by honey mesquite. Common floodplain species include:

Alkali saccaton	(Sporobolus airoides)
Giant dropseed	(S. giganteus)
Tobosa grass	(Hilaria mutica)
Vine-mesquite grass	(Panicum obtusum)
Honey mesquite	(Prosopis juliflora)
Salt cedar, Tamarisk	(Tamarix spp.)

Playa Lake Wetland: The many playa lakes and potholes that dot the High Plains provide some of the most important remaining natural areas in the highly agricultural counties of Texas. Unfortunately, the vegetation of many of the playa lakes has been reduced to a fringe of buffalo grass (Buchloe dactyloides), with most of the emergents and submergents overgrazed or trampled by cattle. Less disturbed lakes may have western wheatgrass (Agropyron smithii) or sideoats grama (Bouteloua curtipendula). Tobosa grass (Hilaria mutica) (in the south) and James galleta grass (Hilaria jamesii) (in the north) may also ring the playas, along with invading mesquite (Prosopis spp.), salt cedar (Tamarix spp.) and willow (Salix spp.). Emergents may include cattails (Typha domingensis), sedges (Eleocharis spp.), spikerushes (Scirpus spp.), and rushes (Juncus spp.). In playa lakes which contain water all year, other emergent, submergent, or playa fringe species may include:

Wild duck millet	(Panicum spp.)
Pond weed	(Potamogeton spp.)
Inland saltgrass	(Distichlis spicata)
Barnyard grass	(Echinochloa crusgalli)
Canary grass	(Phalaris caroliniana)

Canadian Breaks: The Canadian River and the Canadian Breaks are the major remaining large areas of natural vegetation on the Texas High Plains. Cottonwoods (Populus spp.) are the primary large tree bordering the river, with other riparian species as indicated above. In the steep part of the canyon, beyond the riparian zone, junipers (Juniperus spp.) are dominant.

On the shallower slopes is a band of mixed juniper and honey mesquite. Grasses, including blue grama and little bluestem, are also important in the juniper and mixed juniper communities. Beyond the juniper and mesquite is usually a narrow band of grassland primarily of the little bluestem type discussed above. The grassland stops abruptly in farmland as the flat land becomes suitable for cultivation.

Timber Resources: The Texas/New Mexico Alternative Siting Region contains no commercial timber resources. The few trees of the area include honey mesquite; along water courses are cottonwoods, elms, salt cedar and hackberry; pinyon and

juniper are primarily in the northern portions of the siting region. These trees currently have no significant commercial value, although commercial harvesting for the home-heating market may become economically feasible over the next decade. Some ponderosa pine (Pinus ponderosa), a species of commercial importance, occurs in the Canadian Breaks of Harding County, New Mexico, and in extreme northeastern Union County, New Mexico, but the rough and steep terrain prohibits commercial logging (USDA Soil Conservation Service, 1977a, 1980).

PROJECT IMPACTS

Method of Analysis

The impact to natural vegetation was predicted by comparing the full deployment project layout to the known distribution of vegetation types in the area. The data base for vegetation distribution included Bureau of Land Management and Soil Conservation Service vegetation maps, LANDSAT vegetation mapping, field studies conducted for this report, and vegetation distributions presented in the literature. The potential for secondary effects to vegetation was determined using information from past studies of areas where large-scale vegetation removal has occurred. The area-disturbed figures used in the analysis were obtained from the Deployment Area Selection DEIS, Chapter 1. Analysis methodology is discussed further in the section on Principal Significant Impacts.

General Impacts - Nevada/Utah

Construction and operation of the M-X system in Nevada and Utah would potentially impact, to varying degrees, all major vegetation types occurring within the project area. The greatest impacts, in areal extent and severity of disturbance, would affect vegetation types that cover most of the bajada and dry valley bottom land: shadscale scrub, Great Basin sagebrush, and pinyon-juniper woodland (see Figure 2). Less extensive impacts would be expected for other bajada and valley bottom types, including alkali sink scrub, desert marsh and spring vegetation, riparian woodland, creosote bush scrub, and wash and arroyo vegetation. Limited impacts, primarily from recreational activities, would be expected for vegetation types found above the pinyon-juniper zone, including pine-oak forest, montane brush, fir-aspen forest, spruce-fir forest, and alpine vegetation (see Figure 2). Table 6 summarizes the significant impacts to vegetation.

Vegetation Removal: Direct impacts to vegetation would result from the construction of roads and other facilities. Paved roads of the designated transportation network (DTN) would be constructed within a disturbance corridor 100 ft wide. The majority of the vegetation within the disturbance corridors will be removed, while much of the remaining vegetation will be damaged. The total area of vegetation disturbed by DTN construction would range from approximately 14,500 to 20,700 acres. All cluster roads, including side roads to shelters, would be unpaved and constructed within a disturbance corridor 100 ft wide. The total area of vegetation disturbed by the cluster roads would range from approximately 71,500 to 75,200 acres. Construction haul roads, inter-cluster roads, and access roads would be unpaved. Because the length and width of the disturbance corridors for these roads have not been established at the present stage of design, the total area of vegetation which would be disturbed from their construction has not been determined.

Table 6. Sources of potential impacts to vegetation in the Nevada/Utah study area, (Page 1 of 2).

PROJECT TASKS	PROJECT-RELATED ACTIVITIES AND EFFECTS	IMPACTS TO VEGETATION	ASSOCIATED IMPACTS	REMARKS
Construction of permanent roads, (e.g., DTN and cluster), protective structures, buildings (e.g., operating base, support community and construction camp buildings), parking areas, airfields, drainage diversions.	Removal of vegetation by clearing and grubbing.	Permanent loss.	Loss of wildlife habitat. Accelerated wind and water erosion (USEPA, 1973). Reduced forage area for livestock. Increased sedimentation of aquatic and terrestrial habitats. Spread of weedy species, especially alien annuals (Young, et al., 1975). Changes in downslope water supply. Compaction of soil (Taylor and Ashcroft, 1972). Burial of productive surface soils (USEPA, 1975).	Due to the slow reestablishment of vegetation within the Great Basin, the recovery of temporarily lost vegetation to predisturbance density, diversity and productivity levels is not likely to occur within the useful lifetime of the project. The implementation of a comprehensive revegetation program, including steps listed below, would greatly increase the rate and extent of vegetation recovery. Bury excavated materials which are toxic to vegetation. Avoid installation of oversized drainage diversion. Maintain existing surface water flow patterns wherever possible. Excavate quality soil for reapplication to revegetation areas where original soils were shallow or of poor quality. Control fugitive dust generation.
	Deposition of excavated material.	Temporary loss.		
	Modification of surface water flow patterns by elevating roadbeds and installing drainage diversions.	Alter existing vegetation.[1] Loss of certajon species in areas where water supply is decreased (Jarvis, 1969). Increased species diversity and increased productivity of species in areas where water supply is increased (Johnson, et al., 1975).		
	Generation of fugitive dust by construction vehicle operation.	Changes in productivity (Daubenmire, 1974).		
Use of areas for haul roads, staging areas, road shoulders, building perimeters and utility systems.	Removal of vegetation by clearing and grubbing.	Temporary loss.	Loss of wildlife habitat. Accelerated wind and water erosion (USEPA, 1973). Reduced forage area for livestock. Increased sedimentation of aquatic and terrestrial habitats. Spread of weedy species, especially alien annuals (Young, et al., 1975). Changes in downslope water supply. Compaction of soil (Taylor and Ashcroft, 1972). Burial of productive surface soils (USEPA, 1975).	Implement a comprehensive revegetation program, including steps below. Minimize total area cleared. Consolidate disturbance corridors. Minimize depth of soil disturbance. Excavate and directly reapply surface soil. Produce a final surface configuration which minimizes runoff and erosion. Apply mulches to reduce wind and water erosion. Plant suitable vegetation for wildlife habitat, erosion control, and livestock forage. Irrigate to aid in plant establishment. Control access to areas where vegetation is recovering. Implement a post-construction monitoring and treatment program.
	Modification of surface water flow patterns by elevating roadbeds and installing drainage diversions.	Alter existing vegetation.		
	Generations of fugitive dust by construction vehicle operation.	Changes in productivity.		
Excavation of quarries and borrow pits.	Removal of vegetation from clearing, grubbing, and excavation.	Temporary loss.	Loss of wildlife habitat. Accelerated wind and water erosion (USEPA, 1973). Reduced forage area for livestock. Increased sedimentation of aquatic and terrestrial habitats. Spread of weedy species, especially alien annuals (Young, et al., 1975). Burial of productive surface soils (USEPA, 1975). Creation of surface depression with increased water supply.	Minimize number and surface area of quarries and borrow pits. Follow mitigations as listed above.
	Deposition of excavated material.	Temporary loss.		
	Generation of fugitive dust by construction vehicle operation.	Changes in productivity.		

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Table 6. Sources of potential impacts to vegetation in the Nevada/Utah study area, (Page 2 of 2).

PROJECT TASKS	PROJECT-RELATED ACTIVITIES AND EFFECTS	IMPACTS TO VEGETATION	ASSOCIATED IMPACTS	REMARKS
Construction and operation of cement and aggregate plants.	Removal of vegetation by clearing and grubbing.	Temporary loss.	Loss of wildlife habitat. Accelerated wind and water erosion (USEPA, 1973). Increased sedimentation of aquatic and terrestrial habitats. Spread of weedy species, especially alien annuals (Young, et al., 1975). Coating of soil surface by cement dust and formation of surface crust.	Minimize area cleared of vegetation. Confine activities to designated areas. Control dust generation. Follow mitigations listed above.
	Generation of cement dust by plant operation.	Alter existing vegetation. Reduced photosynthetic rates of vegetation coated by dust (Beatley, 1965).		
Withdrawal of groundwater.	Lowering of the groundwater table.	Alter existing vegetation. Loss of vegetation relying on underground water supply (Dallhopf, et al., 1979).	Loss of key wildlife habitat (Dudley and Larson, 1976). Accelerated wind and water erosion (USEPA, 1973). Reduced water supply for livestock. Spread of weedy species, especially alien, annuals (Young, et al., 1975).	Minimize groundwater drawdown in locations where vegetation relies on underground water supplies and where aquatic habitats are supplied by groundwater.
	Decreased groundwater supply to aquatic habitats.	Alter existing vegetation. Loss of riparian habitat (Miller, et al., 1979).		
	Increased fugitive dust resulting from reduced soil moisture (Reinking, et al., 1975).	Changes in productivity.		
Increased personnel access, including off-road security patrols and recreational activities.	Increased use of off-road areas by vehicles.	Alter existing vegetation. Physical breakage of stems and roots (Bury, et al., 1977). Crushing of foliage. Uprooting of small plants and cacti (Wilshire, et al., 1978). Undercutting root systems (Wilshire, et al., 1978). Increased poaching of sensitive or managed plant species.	Loss of wildlife habitat. Accelerated wind and water erosion (Wilshire, et al., 1978). Reduced forage area for livestock. Increased sedimentation of aquatic and terrestrial habitats. Spread of weedy species, especially alien annuals (Young, et al., 1975). Mechanical erosion of soil (Snyder, et al., 1976). Compaction of soil (Wilshire, et al., 1978). Increased incidence of wildfires.	Minimize the need for off-road security vehicle useage. Control access to locations where vegetation is reestablishing. Establish a management program to regulate use of ORV's. Restrict use of ORV's in areas containing sensitive biological resources.
	Increased use of off-road areas by hikers, campers, hunters.	Alter existing vegetation. Trampling and crushing of vegetation (Aitchison et al., 1977). Reduced ground cover and species numbers (LaPage, 1967). Collection of plant material for campfire fuel (Magill, 1963).		

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[1]Altering existing vegetation includes altered productivity, percent ground cover, species diversity, relative species density, and/or species composition.

Construction of each protective structure would disturb 7.5 acres of vegetation, of which 2.5 acres containing the structure would eventually be fenced off from access. Total area of vegetation disturbed from construction of 4,600 protective structures would be approximately 34,500 acres, of which approximately 11,500 acres would be fenced.

Preliminary estimates for disturbance area resulting from construction of surveillance equipment, security buildings, power lines, and maintenance buildings are approximately 2,000 acres. Construction of these facilities would disturb many small areas, of a few acres each, scattered widely throughout the project area.

Preliminary estimates are that temporary facilities associated with construction would disturb approximately 5,000 acres. These facilities include construction camps, cement plants, quarries, borrow pit sites, and marshalling areas. Construction of these facilities would disturb areas of a few acres to several hundred acres, scattered widely throughout the project region. Well sites, each with pipelines, an aggregate manufacturing plant, and a borrow pit, would be located at 30-mi intervals along the DTN. Each well site would disturb approximately five acres of vegetation, giving a total disturbance area of approximately 150 to 310 acres.

The construction activities discussed above would result in both permanent and temporary loss of vegetation cover. Vegetation would be permanently lost from paved and graveled road surfaces (estimated as approximately 46,600 to 53,000 acres for DTN and cluster roads), protective structures, parking lots, and any other facility that is paved or on which a permanent structure is built. The area subject to permanent vegetation removal would be substantially greater than the 46,600 acres, but estimates of the total area are not available at the current stage of engineering design.

Temporary vegetation loss would occur on many areas used during construction and operations. These include construction camps, quarries, borrow pit sites, marshalling areas, portions of the road disturbance corridor, haul roads, and open areas beneath surveillance antennae and power and communication lines. From 58,000 to 69,000 acres of vegetation will be temporarily removed as a result of activities listed above. In addition, over 23,000 acres of vegetation will be temporarily removed during the construction of protective structures.

On the coarse substrates of the bajadas, a disturbance could result in the establishment of Russian thistle (Salsola iberica), which may dominate the site for 15 years (Stewart et al., 1940). If disturbance is not severe or repeated, Russian thistle will gradually give way to a cover of tumble mustard (Sisymbrium altissimum), to be replaced by tansy mustard (Descurainia), and eventually by cheatgrass, or downy brome (Bromus tectorum) (Piemeisel, 1932; 1938). Under conditions of continued disturbance, this successional sequence will revert to Russian-thistle dominance (Evans et al., 1967). In communities where a high density of alien annual grasses, such as cheatgrass (Bromus tectorum), has become established, the reestablishment of sagebrush is inhibited due to frequently reoccurring fires (Young and Evans, 1978). Both the anticipated increased establishment of alien annuals in areas disturbed by M-X system construction, and the increased chance of fires from higher populations associated with the M-X system could contribute to the development of low productivity, fire disclimax communities.

Halogeton: On finer substrates of the low bajadas and lakeplains, Halogeton glomeratus, a poisonous weed introduced from central Asia, quickly establishes after disturbance. Under conditions of light disturbance, halogeton is gradually replaced by rabbitbrush, winterfat, or shadscale. Under more severe or repeated disturbance, halogeton can alter the soil chemistry to the extent that native vegetation is excluded (Cook and Stoddart, 1953). Site modification by halogeton may prevent native species reestablishment for more than 50 years (Eckert and Kinsinger, 1960). Halogeton is now found throughout most of the shadscale zone and in some lower elevation areas of the sagebrush zone. Because it is toxic to livestock, halogeton has reduced or eliminated grazing in many areas (Cook and Stoddart, 1953). Recent studies suggest that the only effective method for control of halogeton is by competition with perennial species (Cleaves and Taylor, 1979). The potential for halogeton spread as a result of M-X deployment is evaluated further in Appendix A of this report.

Revegetation and Succession Characteristics: The natural reestablishment of vegetation may occur if substrate suitable for plant growth is present. The pattern and rate of natural revegetation in a given area is dependent upon such factors as the ability of selected species to establish on disturbed sites, the annual rate of precipitation, the reliability of precipitation, the wind conditions, and substrate characteristics. Natural revegetation may be inhibited if the soil has been compacted, covered with overburden materials unsuitable for plant growth, or if the surface soil is removed, exposing toxic subsoil, hard soil layers or bedrock. The time period required for recovery of the native vegetation to predisturbance density, diversity, and productivity is unknown. Based on past studies on natural revegetation and successional patterns in the Great Basin, it is thought that natural recovery of vegetation, to predisturbance conditions, would not occur within the useful lifetime of the M-X system. A National Academy of Sciences study committee (National Academy of Sciences, 1974) stated that natural rehabilitation of sites of the type found in the study area may take decades to centuries. Substantial quantities of dust, sediment, and runoff water would be discharged from disturbed areas until a vegetative cover is reestablished. The implementation of a comprehensive revegetation program, including reapplication of surface soil, planting suitable vegetation, irrigating and minimizing repeated disturbance, would greatly increase the rate of vegetation recovery. Seeding efforts usually fail in areas that receive less than 8 in. of precipitation annually (which includes roughly 80 percent of the potentially disturbed area), unless irrigation is used.

Degradation of Existing Vegetation: In addition to areas where vegetation would be removed completely, there will be many other areas where construction and operations activities would result in degradation of existing vegetation. Degradation would occur in the form of changes in species composition, relative species abundance, productivity, and total percent cover. These changes may result from a number of project-related factors, including increased occurrence of fugitive dust and other air pollution, increased erosion and soil compaction, changes in surface and subsurface water flow patterns and groundwater drawdown.

Fugitive dust would be produced by vehicles traveling on unpaved construction haul roads and other unpaved roads, and by wind erosion of disturbed areas (Reinking et al., 1975). Other forms of air pollution would result from the operations of vehicles, cement plants, quarries, and related activities. Dust and air pollution cause differential changes in productivity between species (Waldbott, 1978;

Daubenmire, 1974; Jacobson and Hill, 1970), so that resulting impacts would be in the form of changes in species composition, if the effects are sufficiently strong and persistent (Wood, 1976). Daubenmire (1974) indicates that plants with deciduous leaves suffer least from photosynthesis inhibition as a result of surficial covering, while evergreen species suffer more damage. Beatley (1965) has observed defoliated creosote bush plants (Larrea divaricata), which occur in the southern part of the project area, and attributed the defoliation to heavy coverings of dust. In some cases (Pajenkamp, 1961; Raymond and Nussbaum, 1966) fugitive dust has not been found to be harmful to plants.

Vegetation nearest to point sources of dust, such as cement plants, and air pollution, and in areas where these pollutants are concentrated because of climatic characteristics and wind patterns, are likely to be most heavily affected (Daubenmire, 1974). Wood (1976) observed vegetational gradients in Sonoran Desert vegetation surrounding a copper smelter plant in Arizona. He found a high correlation between distance from the shelter and abundance of most plant groups. For the M-X project, greatest effects on vegetation from fugitive dust would be expected near cement plants, oil-fueled generators, and other long-term point sources. Areas where low levels of dust would be produced intermittently, for example, along roadsides, near borrow pits and protective structures, where soil is likely to be disturbed, will be less seriously impacted.

Construction and operation activities would result in increased soil erosion and compaction, degrading existing vegetation. Construction and operation activities that reduce vegetation cover and break desert pavement would accelerate wind erosion. The destructive effects of wind erosion include loss of productive topsoil, exposure of root systems to desiccation, and abrasion and burial of vegetation (Brady, 1974). Exposure of soils to water erosion results in flooding, sedimentation, and the loss of surface soil (Clyde et al., 1978; USEPA, 1973). Soil compaction, from construction activities and off-road vehicle use, would degrade vegetation by restricting root penetration and by reducing soil aeration and water infiltration (Taylor and Ashcroft, 1972). Both soil erosion and compaction could result in changes in vegetative cover, species composition, plant productivity, and could reduce the potential for reestablishment of native or ornamental vegetation.

The construction of drainage diversions, which channel water away from some areas and concentrate it in other areas, may cause both short and long term changes in vegetation. Some areas will receive less surface flow than previously. This could result in a change in species composition. Existing species which are more drought tolerant may become more abundant, while those species which are less drought tolerant may decline in size and may eventually be eliminated due to inability to grow and reproduce. Areas where surface flow is increased may experience increased erosion (Brady, 1974). These eroded areas which may initially suffer loss of vegetation, may eventually be colonized by a variety of Eurasian weeds and certain native species, such as rubber rabbitbrush, that can tolerate these conditions (Young, 1972; Shields et al., 1963). In addition to erosion effects, increased soil moisture may locally increase productivity of existing plants (Johnson et al., 1975) and may eventually result in the establishment of new species that require these higher moisture levels (Wallace and Romney, 1972). Field studies are currently underway to examine the impacts of water diversion on downslope vegetation.

Pumping underground water to supply the needs of construction and operations may result in groundwater drawdown (Los Angeles Department of Water and Power,

1976), and in decreased subsurface irrigation (Dallhopf et al., 1979), which could cause widespread, short and long term impacts to vegetation (Jarvis, 1969).

Lowering of the water table would affect vegetation types dominated by species that are dependent on relatively abundant subsurface water, including riparian woodland (Miller et al., 1979), desert marsh and spring vegetation (Jarvis, 1969), and wash and arroyo vegetation. Groundwater drawdown has decreased water levels in springs in the Death Valley region (Dudley and Larson, 1976); similar results would be expected in the project area. Potential changes in marsh and spring vegetation include changes in species composition, with loss of the most water-dependent species, decreases in productivity of the remaining vegetation (Jarvis, 1969), encroachment by upland drought-adapted types, and possibly invasion of degraded aquatic habitats by Eurasian weeds tolerant of saline and alkaline soils (Cook and Stoddard, 1953; Young et al., 1972).

Since riparian vegetation depends on high levels of soil moisture, a factor that is correlated with a high water table (Miller et al., 1979), changes in riparian vegetation could occur as a result of groundwater drawdown. These changes could include decreased productivity and a gradual loss of those species requiring the greatest amounts of water, such as velvet ash (Fraxinus velutinus) and box elder (Acer negundo).

Lowering the water table or altering subsurface water flow patterns would affect native vegetation and crops that rely on natural subsurface water supplies. Successful cultivation of alfalfa, a leading crop of the project region, is often dependent upon natural subsurface irrigation (Dallhopf et al., 1979). If natural subsurface water supplies were reduced, the yield of alfalfa could decline unless the water lost is replaced by surface irrigation (Dallhopf et al., 1979). Groundwater drawdown would also affect desert plant species, with deep taproots, that depend on subsurface water supplies. Examples of these species from the project area include greasewood (Sarcobatus vermiculatus), mesquite (Prosopis glandulosa), and desert willow (Chilopsis linearis).

Forage Impacts: One of the major impacts to occur from reduction of the vegetation cover in the affected valleys would be a reduction in the livestock grazing capacity. Impacted grazing lands would include many acres of creosote bush scrub, alkali sink scrub, shadscale, Great Basin sagebrush, and pinyon-juniper woodland vegetation types throughout the project region. These areas support large populations of livestock, feral horses and burros, and native large herbivores. Most of the vegetation impacts from M-X deployment would occur in the sagebrush and shadscale vegetation types. Sagebrush vegetation occurs in the higher elevation, usually moister, and more productive regions of the valleys. It is used primarily for non-winter grazing. The lower, drier sites with shadscale vegetation are used primarily for winter grazing.

The plant species which would be impacted vary considerably in forage production. Some widespread and abundant species, such as big sagebrush (Artemisia tridentata) and species of rabbitbrush (Chrysothamnus spp.), are only lightly utilized. Other species, such as winterfat (Eurotia lanata), antelope bitterbrush (Purshia tridentata), and palatable grasses, are less abundant, but local concentrations can provide a high percentage of the forage for some regions. Improved rangelands (areas where the native shrubby vegetation has been removed

and perennial grasses have been planted), also provide a high percentage of the forage for some regions. Significant changes in regional grazing capacity can occur if these localized, productive areas containing valuable species are impacted.

Heavy overgrazing during the late 19th and early 20th centuries has caused major changes in plant species presence and in relative composition, and has generally reduced the productivity and decreased the livestock carrying capacity of many Great Basin rangelands (Stoddart, Smith and Box, 1975; Young et al., 1976). The successional patterns in many Great Basin sagebrush and shadscale communities have profoundly changed as a result of overgrazing. (Holmgren and Hutchins, 1972; Young et al., 1972).

The shadscale vegetation type, which sometimes includes pure or nearly pure stands of winterfat, is a highly variable and often unpredictable community in terms of secondary succession patterns following disturbance. Many areas which in the past supported distinctive plant associations reflecting local conditions, now support a similar, degraded vegetation as a result of grazing impacts (Holmgren and Hutchings, 1972). Often, grazing has altered a community to the extent that its original composition is no longer discernible and its current pattern of recovery is uncertain. The altered recovery patterns appear to result from modified plant-soil relationships that are little understood (Holmgren and Hutchings, 1972).

In many sagebrush communities, grazing has reduced or eliminated the perennial grasses, and changed the shrub composition in many ways. Shrubs that are least preferred for grazing, including the dominant species of Artemisia, have increased in dominance, while preferred forage species have become less common. Introduced annuals such as Russian thistle (Salsola iberica), tumbling mustard (Sisymbrium altissimum), and cheatgrass (Bromus tectorum), are now so widespread, and form such a complete understory in some degraded communities, that reestablishment of native perennial grasses is often precluded (Young and Evans, 1973). Under these circumstances, fire behavior and secondary succession are also altered (Young et al., 1976; Young and Evans, 1978). Without additional disturbance, Russian thistle will be gradually replaced by sagebrush on many of the higher elevation sites (Holmgren and Hutchings, 1972). Similar patterns of introduced species establishment have resulted from past overgrazing of other vegetation communities in the potentially impacted valleys.

Indirect Impacts: Indirect impacts to vegetation would result from activities associated with increases in population occurring in response to development of the M-X system. Construction of facilities to accommodate increased population levels would result in vegetation removal and degradation. Additional impacts to vegetation are expected from increased recreational use of certain areas, including ORV activities, and increased visitations to areas that were previously less accessible. The area of vegetation that would be lost or degraded has not been quantified at this time.

All major vegetation types found in the project area would potentially receive indirect impacts from the project. Those vegetation types found near existing towns would receive the greatest impacts from town expansion. These vegetation types include alkali sink scrub, creosote bush scrub, wash and arroyo vegetation, riparian woodland, desert marsh and spring vegetation, shadscale scrub, Great Basin sagebrush and pinyon-juniper woodland. The greatest vegetation impacts, in areal extent

and severity of disturbance, would occur to shadscale scrub, Great Basin sagebrush, and pinyon-juniper woodland. Other major vegetation types, including pine-oak forest, montane brush, spruce-fir forest, and alpine vegetation, are more likely to be impacted by increased recreational use and increased visitation to previously less accessible areas.

Permanent and temporary vegetation loss would result from construction of new houses, roads, stores, schools, power and communication lines, and other buildings and facilities associated with population increases. Vegetation would be permanently lost in areas that are paved or where a permanent structure is built. Those areas where vegetation is removed, but where substrate suitable for vegetation reestablishment remains, have the potential for vegetation reestablishment. A discussion of the natural revegetation and successional characteristics of some of the major vegetation types in the project area is presented in the affected environment section of this report.

In addition to those areas where vegetation would be completely removed, there are areas where degradation of existing vegetation would occur as a result of town expansion and recreatonal activities. Degradation could occur in the form of changes in species composition, abundance, productivity, and total percent cover. Increased levels of fugitive dust and other air pollution, increased erosion and soil compaction, changes in surface and subsurface water flow patterns and groundwater drawdown would result in vegetation degradation. Each of these factors is discussed in more detail above under direct impacts.

Development of the M-X system would increase the use of off-road vehicles (ORVs) in the project area. The impacts to vegetation by ORVs are both direct and indirect (Davidson and Fox, 1974; Duck, 1978; Keefe and Berry, 1973; Wilshire et al., 1978). Direct impacts include crushing of the foliage, uprooting of small plants and cacti, and disruption of root systems of larger plants by soil shear stresses (USGS, 1977). The undercarriage of vehicles may damage stems and foilage, and extend plant damage over an area much larger than the wheel track width. Motorcycles are capable of opening trails in moderately dense vegetation. Fourwheeled vehicles can open trails among plants as large as Joshua trees and junipers (Wilshire et al., 1978). The total amount of vegetation impacted can be substantial. Shrub biomass was reduced 50 percent by "moderate" ORV use, and 70 percent by "heavy use" in areas of the California desert (Bury et al., 1977). Densities of annual plants were found to be significantly lower in tire ruts than in the surrounding areas of the Mojave desert (Ullmer et al., 1976).

Indirect impacts of ORVs on vegetation include undercutting of root systems as vehicle paths are enlarged by erosion, development of new erosion channels in areas not previously used by vehicles, burial of plants with eroded materials, and loss of fertile topsoil. Unstable highs and lows, resulting from mechanical erosion of soil by ORVs, tend to be worn down and filled in through time. Soil and vegetation cover on the highs are lost by either gradual reduction or by a mass wasting processes. In areas stripped of vegetation, wind erosion may be accelerated, causing sandblasting of nearby vegetation. Vegetation burial from the deposition of eroded materials may occur near or distant from the source of the erosion (Wilshire et al., 1978). Loss of the fertile surface soil or physical modifications of the soil by ORV use has been shown to inhibit or prevent revegetation (Webb et al., 1978; Wilshire et al., 1978).

Comparison of Unique Vegetation Features by Hydrologic Subunit: Table 7 lists the abundance, sensitivity to impact, and quality of data for unique vegetation features occurring in project area hydrologic subunits. Table 8 lists the unique vegetation features that are located in the valley bottoms or bajadas and therefore may be directly impacted by project construction. Unique vegetation features are defined as features that are atypical, unusual, or in some way unique, are are not common or widespread enough to be considered vegetation types. The unique vegetation category does not include rare, threatened, or endangered plant species unless they have one of the characteristics discussed below. The following were included as unique vegetation features:

1. Range extensions: Areas where a certain species reaches the limit of its range, or occurs as a disjunct population. For example, regions where the Joshua tree reaches the northermost extent of its geographic distribution.

2. Relict populations: Areas, usually at high elevations, where a certain species or group has remained unaltered for long periods of time. They are the remaining populations of plant species or communities whose distributions were once more widespread. Boreal forests consisting of ponderosa pine (Pinus ponderosa) and bristlecone pine (Pinus longaeva) are examples. Relicts are not necessarily rare.

3. Unusual ecotypes: Areas where, for unknown reasons, plants occur in a habitat which is radically different from the normal habitat associated with that plant. For example, an occurrence of Rocky Mountain juniper (Juniperus scopulorum) in a low marshy zone.

4. Hybridization zones: Areas where species are intergrading and undergoing "explosive evolution" (experiencing rapid rates of change). These areas are considered unique if they are currently being studied or have been clearly identified.

5. Aquatic or wetland vegetation: Areas where riparian, marsh or distinctive spring vegetation are known to occur. These areas are not common in the Great Basin and are considered unique only if verified by field data or if documented in literature.

6. Bald mountains: Mountains or peaks which contain a sagebrush grass zone at the summit, above the pinyon-juniper zone at elevations where trees would be expected.

7. Joshua tree zones: Areas in which the Joshua tree (Yucca brevifolia) is known to occur. The limited distribution of this plant association within the project area includes the northernmost populations of the Joshua tree.

8. Alpine or sub-alpine vegetation: Treeless areas at high elevations; known in the study area only from a few mountain ranges such as the Deep Creek and Snake Ranges.

9. Sand dune vegetation: Species which occur on sand dunes are often substantially different from those of the surrounding community (Stutz, et al., 1975).

Table 7. Abundance and sensitivity to impact of unique vegetation in Nevada/Utah.

HYDRO-GRAPHIC UNIT NUMBER	LOCATION	A	S	HYDRO-GRAPHIC UNIT NUMBER	LOCATION	A	S
3	Deep Creek	H	I	151	Antelope	L	L
4	Snake	H	H	152	Stevens	L	L
5 (U)	Pine	I	L	153	Diamond	I	I
6	White	L	L	154	Newark	L	L
7	Fish Springs	I	H	155	Little Smoky	I	H
8	Dugway	L	L	156	Hot Creek	H	H
9	Government Creek	L	L	169a	Tikaboo-Northern	H	I
13	Rush	L	L	170	Penoyer	L	L
32b	Great Salt Lake Desert-Western Desert	H	I	171	Coal	L	L
				172	Garden	H	I
46	Sevier Desert	I	H	173a	Railroad-Southern	I	I
46a	Sevier Desert-Dry Lake	L	L	173b	Railroad-Northern	I	H
47	Huntington	L	L	174	Jakes	L	L
50	Milford	L	L	175	Long	L	L
52	Lund District	L	L	176	Ruby	H	H
53 (N)	Pine	I	I	178	Butte	I	I
53 (U)	Beryl-Enterprise District	L	L	179	Steptoe	H	I
54 (U)	Wah Wah	L	L	180	Cave	I	I
54 (N)	Crescent	I	H	181	Dry Lake		I
55	Carico Lake	L	L	182	Delamar	I	H
56	Upper Reese River	H	H	183	Lake	I	I
57	Antelope	L	L	184	Spring	H	H
58	Middle Reese River	I	H	185	Tippett	L	L
122	Gabbs	L	L	186	Antelope	L	L
124	Fairview	L	L	187	Goshute	I	I
125	Stingaree	L	L	194	Pleasant	[illegible]	L
126	Cowkick	L	L	196	Hamlin	H	I
127	Eastgate	L	L	198	Dry	I	I
133	Edwards Creek	L	L	199	Rose	L	L
134	Smith Creek	L	L	200	Eagle	L	L
135	Ione	L	L	201	Spring	L	L
136	Monte Cristo	L	L	202	Patterson	[illegible]	I
137a	Big Smoky-Tonopah Flat	I	H	203	Panaca	[illegible]	I
137b	Big Smoky-North	I	H	204	Clover	L	L
138	Grass	L	L	205	Meadow Valley Wash	I	H
139	Kobeh	I	I	206	Kane Springs	L	H
140	Monitor	H	H	207	White River	H	H
141	Ralston	I	H	208	Pahroc	L	L
142	Alkali Spring	I	I	209	Pahranagat	H	H
143	Clayton	H	I	210	Coyote Springs	H	H
144	Lida	I	H	219	Muddy River Springs	L	L
149	Stone Cabin	L	H	128	Dixie	L	L
150	Little Fish Lake	I	H	129	Buena Vista	L	L
				132	Jersey	L	L

229[illegible]

A = Abundance
S = Sensitivity to impact
Q = Quality of data
H = High; I = Intermediate; L = Low

Table 8. Unique vegetation potentially directly affected by project construction (features known to occur in valley bottom or bajada habitats).

VALLEY NUMBER	VALLEY NAME	UNIQUE FEATURE
4	Snake	Riparian vegetation - Birch Creek Spring vegetation - 5 locations
7-Utah	Fish Springs	Marsh vegetation
46-Utah	Sevier Desert	Sand dune vegetation - Little Sahara dunes
142	Alkali Springs	Northern extension of Joshua tree *(Yucca brevifolia)*
155a, c	Little Smokey	Unusual dominance of *Sphaeralcea* sp. on undisturbed sites
156	Hot Creek	Riparian vegetation - Eden Creek Marsh vegetation - Keystone Spring
173B	Railroad-North	Spring vegetation - North and Big Springs, Riparian vegetation - Currant Creek
179	Steptoe	Riparian and marsh vegetation - Comins Lake
181	Dry Lake	Location of Joshua tree stand
182	Delamar	Location of Joshua tree stand
184	Spring	Location of pygmy sage *(Artemisia pygmaea)* and "swamp cedars" *(Juniperus scopulorum)*
207	White River	Riparian and marsh vegetation gypsum mounds with endemic species
209	Pahranagat	Scattered Joshua tree locations riparian, marsh vegetation
210	Coyote Springs	Scattered Joshua tree locations

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If data showed that a hydrologic subunit contained more than one unique vegetation feature, it was given a high abundance rating. If data showed that a subunit contained only one unique vegetation feature, it was given an intermediate rating. If no unique features were known to occur in the subunit, it was rated as low.

Sensitivity to impact was considered high if the unique vegetation occurred on the valley floor or bajada, since this area is most likely to be affected by the project. Sensitivity to impact was considered intermediate if the unique vegetation occurred in mountains nearby. Those subunits which had no known unique vegetation features were rated as low.

The quality of the data was considered high if: (a) information had been gathered from field reconnaissance or personal communication, or (b) the region, area, or population was listed and mapped in Bostick and Niles, 1975, or (c) information was gathered from other literature sources. Although high quality is specific enough to indicate the presence of unique vegetation in a subunit, these data are sometimes not specific enough to show the precise location of the feature, or the details of the plant association where it occurs. If information specific enough to indicate the presence of unique vegetation in a particular subunit was not available, data quality was considered low. The intermediate category was not used for data quality. High quality data pertaining to the distribution of wetland vegetation types are lacking for many subunits.

General Impacts - Texas/New Mexico

Impacts from construction and operation will be primarily from population increases due to construction and operation. Sources of impact to vegetation in the Texas/New Mexico study area are summarized in Table 9.

Because almost 90 percent of the deployment area is in agriculture or rangeland, direct impacts to vegetation will be mainly to these types; impacts to relatively undisturbed natural vegetation will occur in a smaller area. The size of the area of natural vegetation that will be affected cannot be precisely determined because most of the natural vegetation exists in small patches of unknown size between areas of clean farming and intensively grazed rangeland. Most areas of extensive natural vegetation are found in geotechnically unsuitable regions, such as the Canadian River drainage, the sand hills, and the oil and gas fields, which make up approximately 8 percent of the total land area. (See Figure 3 for potential natural vegetation of the study area.)

Direct impacts to the existing natural and agricultural vegetative cover will result from construction of roads and ancillary facilities. Paved roads of the designated transportation network (DTN) will be constructed within a disturbance corridor 125 ft wide. The total area used for DTN construction will be approximately 24,000 acres, which includes some area of previously disturbed section roads which require widening. All cluster roads, including side roads to shelters, will be unpaved and constructed within a disturbance corridor 100 ft wide. The total area disturbed by the cluster roads will be approximately 63,000 acres. Construction haul roads will be unimproved dirt roads. The width of the disturbance corridor of the construction haul roads and the total acreage to be disturbed have not been determined.

Table 9. Sources of potential impacts to vegetation in the Texas/New Mexico study area. (Page 1 of 2)

PROJECT TASKS	PROJECT-RELATED ACTIVITIES AND EFFECTS	IMPACTS TO VEGETATION	SOURCES OF ADDITIONAL VEGETATION IMPACTS	REMARKS
Construction of permanent roads, (e.g., DTN and cluster), protective structures, buildings (e.g., operating base, support community and construction camp buildings), parking areas, airfields, drainage diversions.	Removal of vegetation by clearing and grubbing. Deposition of excavated material. Modification of surface water flow patterns by roadbeds. Generation of fugitive dust by construction vehicle operation.	Permanent loss. Temporary loss. Altering existing vegetation (Jarvis, 1969). Changes in productivity possible, but probably localized (Beatley, 1965).	Accelerated wind and water erosion (USEPA, 1973). Reduced forage area for livestock. Increased sedimentation of aquatic and terrestrial habitats. Compaction of soil (Taylor & Ashcroft, 1972). Burial of productive surface soils (USEPA, 1975).	Some recovery of temporarily lost vegetation is likely to occur within several years. The implementation of a comprehensive revegetation program, including steps listed below, would greatly increase the rate and extent of vegetation recovery. Bury excavated materials which are toxic to vegetation. Maintain existing surface water flow patterns wherever possible. Excavate quality soil for reapplication to revegetation areas where original soils were shallow or of poor quality. Control fugitive dust generation
Use of areas for haul roads, staging areas, road shoulders, building perimeter and utility systems.	Removal of vegetation by clearing and grubbing. Modification of surface water flow patterns by roadbeds.	Temporary loss. Altering existing vegetation.	Accelerated wind and water erosion (USEPA, 1973). Reduced forage area for livestock. Increased sedimentation of aquatic and terrestrial habitats. Compaction of soil (Taylor & Ashcroft, 1972). Burial of productive surface soils (USEPA, 1975).	Implement a comprehensive revegetation program. Minimize total area cleared. Consolidate disturbance corridors. Minimize depth of soil disturbance. Excavate and directly reapply surface soil. Produce a final surface configuration which minimizes erosion and runoff. Apply mulches to reduce wind and water erosion. Plant suitable vegetation for wildlife habitat, erosion control, and livestock forage. Control access to areas where vegetation is recovering. Implement a post-construction monitoring and treatment program.

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Table 9. Sources of potential impacts to vegetation in the Texas/New Mexico study area. (Page 2 of 2)

PROJECT TASKS	PROJECT-RELATED ACTIVITIES AND EFFECTS	IMPACTS TO VEGETATION	SOURCES OF ADDITIONAL VEGETATION IMPACTS	REMARKS
Excavation of quarries and borrow pits.	Removal of vegetation from clearing, grubbing, and excavation. Deposition of excavated material. Generation of fugitive dust by construction vehicle operation.	Temporary loss. Temporary loss. Changes in productivity possible, but probably localized (Beatley, 1965).	Accelerated wind and water erosion (USEPA, 1973). Reduced forage area for livestock. Increased sedimentation of aquatic and terrestrial habitats. Burial of productive surface soils (USEPA, 1975). Creation of surface depressions with increased water supply.	Minimize number and surface area of quarries and borrow pits. Follow mitigations as listed above.
Construction and operation of cement and aggregate plants.	Removal of vegetation by clearing and grubbing. Generation of cement dust by plant operation.	Temporary loss. Changes in productivity possible, but probably localized (Beatley, 1965; Treshow, 1970).	Accelerated wind and wind erosion (USEPA, 1973). Increased sedimentation of aquatic and terrestrial habitats. Coating of soil and surface by cement dust and formation of surface crust (Treshow, 1970).	Minimize area cleared of vegetation. Confine activities to designated areas. Control dust generation. Follow mitigations listed above.
Withdrawal of groundwater.	Lowering of the groundwater table.	No effect.	No effect.	Groundwater not connected to surface waters.
Increased personnel access, including off-road security patrols and recreational activities.	Increased use of off-road areas by vehicles.	Alter existing vegetation. Physical breakage of stems and roots. Crushing of foliage. Uprooting of small plants and cacti. Undercutting root systems (Bury, et al., 1977, Wilshire, et al., 1938).	Reduced forage areas. Increased sedimentation of aquatic and terrestrial habitats. Mechanical erosion of soil (Snyder, et al., 1976). Compaction of soil (Wilshire, et al., 1978).	Minimize the need for off-road security vehicle usage. Control access to locations where vegetation is reestablishing. Establish a management program to regulate use of ORVs. Restrict use of ORVs in areas containing sensitive biological resources.

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[1]Altering existing vegetation includes altered productivity, percent ground cover, species diversity, relative species density, and/or species composition.

Construction of each missile shelter will disturb 7 1/2 acres, of which 2 1/2 acres containing the shelter will eventually be fenced off from access. Total area disturbed from shelter construction will be approximately 35,000 acres, of which approximately 11,500 acres will be fenced off.

Construction of surveillance equipment, security buildings, power lines, and maintenance buildings will disturb a total of approximately 1,000 acres. A breakdown of amounts of acreage disturbed for each individual component is not available at this time.

Vegetation will be removed from areas used temporarily during construction and operations. These include construction camps, quarries, borrow pit sites, marshalling areas, portions of the road disturbance corridor, and open areas beneath surveillance antennae and power and communication lines. At least 10,000 acres will be temporarily disturbed as a result of activities listed above. Individual acreages for different types of temporary disturbances are not presently available. Most of the acreage that would be disturbed by the project is presently in agriculture or pasturage.

Natural vegetation types potentially affected by construction and operation include six of the eleven major vegetation types of the project area: blue grama grassland, mixed grama grassland, bluestem grassland, mesquite grassland, upland breaks, and playa lake wetland (Table 10). Playa lake wetlands are unsuitable for agriculture and this type is the most abundant natural vegetation type in farmed areas. Playa habitat in rangeland tends to be grazed heavily, with concomitant loss of native vegetation. Other natural vegetation types cover less area.

All 11 major vegetation types are found outside the deployment area, and may be affected indirectly by the project. Intensive recreational use of open lands, especially involving off-road vehicles, is notorious for destruction of vegetation (Sheridan, 1979). The sand hill areas, which support a unique assemblage of plants, are especially attractive to ORV users. They are unfenced and not used agriculturally, and could suffer extensive damage. The diverse vegetation of the Canadian and Pecos rivers drainage areas could be impacted similarly. They are open lands with a few areas of dense woody vegetation. Both camping and ORV use, if concentrated, could cause localized destruction of vegetation and soil compaction, which effectively prevents revegetation, leaving the soil vulnerable to erosion. Keefe and Berry (1973) discuss the impacts to Dove Springs Canyon in the western Mojave Desert, which has a total area of 5,000 acres. In the last decade, ORV use has denuded 543 acres and damaged another 960. Similar use of a nearby canyon has resulted in soil loss of 11,000 metric tons. Studies of the results of recreational use on vegetation and soils have shown a number of adverse impacts. Frissell and Duncan (1965) report a loss of 80 percent of total groundcover in campsites in Michigan with light use. Arid regions are highly susceptible to vegetation impacts from recreational use (Wilshire et al., 1979).

Increased recreational use would also increase the possibility of accidental fires, which would pose a threat to the areas of woody vegetation, especially in the upland breaks, but would have no adverse effect on grasslands (Wells, 1970).

The real extent of these impacts would be potentially greater in New Mexico than in Texas, because most of the land in Texas is privately held. The New Mexico

Table 10. Major vegetation types in the Texas/New Mexico study area.

TYPE	GENERAL LOCATION	COMPOSITION	SOURCE OF PRESENT DISTURBANCE
Blue Grama Grassland	Clay-Clay Loam Soils, North-Northeast Portions	Blue Grama, Buffalo Grass Co-dominance	Agriculture, Grazing
Mixed Grama Grassland	Silt Loam-Sandy Loam, Most of High Plains	Blue Grama, Side-Oats Grama, Purple Three-Awn	Agriculture, Grazing
Bluestem Grassland	Sandy Soils	Little Bluestem, Side-Oats Grama, Sand Bluestem, Sand Sage, Shinnery Oak	Grazing, Agriculture, Oil Fields
Mesquite Grassland	Overgrazed Grassland	Honey Mesquite, Blue Grama, Little Bluestem	Overgrazing, ORVs
Sand Dune	Sand	Shinnery Oak, Sand Sage	Grazing, Hunting, ORVs
Desert Grassland	Western Edge, Dry High Plains	Black Grama, Tobosa Grass, Fluff Grass, Soaptree Yucca	Grazing, Hunting, ORVs
Chihuahuan Desert Scrub	Southern Edge, High High Plains	Creosote Bush, Black Grama, Bush Muhly	Grazing, Hunting, ORVs
Upland & Canyon Breaks	Gravelly Loam, Rolling to Steep Slopes	Juniper, Mesquite, Oak	Grazing, Hunting, ORVs
Stream Riparian	Stream Valleys	Cottonwood, Hackberry, Willows, Mesquite, Tamarisk	Hunting, Grazing, Camping, ORVs
Floodplain	Salty Floodplains	Alkali Sacaton, Giant Dropseed	Grazing, ORVs
Playa Lake Wetland	Playa Lakes on High Plains, Clay Soils	Buffalo Grass, Wheat-grass, Cattail, Bulrush, Willow	Agriculture, Grazing

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area is a mixture of federal, state, and private lands that is mainly fenced range. The federal and state lands form the largest contiguous blocks and are potentially susceptible to recreational impact.

Abundance, sensitivity to impact, and data quality were analyzed by county for three vegetation types: shinnery oak/sand sage, wetland/riparian, and upland breaks. The categories were rated high, intermediate, or low, using the following criteria.

If a country contains two or three unique vegetation associations or types, it is given a high abundance rating. If the data show that a county contains only one unique vegetation type, it is given an intermediate rating. If no unique types are known to occur in the county, it is rated as low.

Sensitivity to impact is considered high if the unique vegetation occurs in geotechnically suitable areas. Sensitivity to impact is considered intermediate if the unique types occur in adjacent areas. Those counties which have no known unique types are rated as low.

The quality of the data is considered high if the region, area, or population is listed and mapped in region or site-specific surveys (e.g., USDA, 1977) gathered from other literature sources. If specific information indicating the presence of unique vegetation in a particular county is not available, data quality is considered low. The intermediate category is not used. Four counties are rated high in abundance (Table 11). Cochran and Randall counties in Texas contain both wetland/riparian and shinnery oak habitat, but impact sensitivity is ranked intermediate because these habitats are outside the deployment area. Chaves and Roosevelt counties in New Mexico contain wetland/riparian, shinnery oak/sand sage, and upland break habitats, and the latter two are in the deployment area, with high impact sensitivity.

Counties that are involved in one or more specific system layouts, and that were ranked high in abundance and sensitivity for unique vegetation were used as examples (Table 11). The following examples indicate specific areas geotechnically suitable for project siting but which have comparatively high impact potential for a particular resource.

<u>Principal Significant Impacts: Comparison of Project Alternatives</u>

The native vegetation in the two basing areas forms the base of a diverse community of plants and animals, coadapted to harsh environments. Owing to thousands of years of adaption to the harsh climatic and soil conditions, the native vegetation is the most stable vegetative cover available. Few non-native species (particularly in portions of the Nevada/Utah project area) possessing the beneficial attributes of the native vegetation, can be established in these areas. The existing native vegetation has many functional attributes. The native vegetation is at the base of the food chain. It provides a habitat for wildlife and is the basic resource of the livestock industry. Vegetation protects the soil from erosion, minimizes sediment discharge from wind and water erosion, and greatly reduces the occurence and magnitude of floods. Vegetation also aids percolation of precipitation to groundwater storage, builds desirable soil characteristics, and provides for an aesthetic environment for recreation.

Table 11. Abundance, sensitivity to impact, and data quality for unique vegetation, Texas/New Mexico High Plains.

COUNTY (STATE)	UNIQUE VEGETATION[1]		
	A	S	Q
Bailey (TX)	I	I	H
Castro	L	L	H
Cochran	H	I	H
Dallam	L	L	H
Deaf Smith	I	H	H
Hartley	I	H	H
Lamb	I	I	H
Moore	I	I	H
Oldham	I	I	H
Parmer	L	L	H
Randall	H	I	H
Sherman	L	L	H
Chaves (NM)	H	H	H
Curry	I	H	H
DeBaca	I	L	H
Guadalupe	I	L	H
Harding	I	L	H
Lea	I	L	H
Quay	I	H	H
Roosevelt	H	H	H
Union	I	L	H

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[1]Shinnery oak/sand sage, wetland/riparian, juniper break (Texas only).

A = Abundance S = Sensitivity to impact Q = Quality of data.

Once the native vegetation is removed, natural recovery is projected to take from a few decades to over a century. Plants and animals which currently dominate will be replaced by species which thrive in disturbed areas. Where vegetative cover is removed and the soil is disturbed, environmental conditions are such that substantial rehabilitation measures are required to restore the vegetation and wildlife habitat and to restore the functional attributes provided by a vegetative cover.

Although the vegetation types in the Nevada/Utah study area have a rather uniform aspect over wide areas, this uniformity masks substantial local differentiation. For example, sagebrush vegetation may be dominated by one or more of five species or subspecies, each which exhibit substantial variation, depending on geographic location and site characteristics. In addition, the group of species associated with the dominant species also changes markedly from place to place. Existing within areas which support widespread vegetation types are many unique kinds of vegetation, such as relict populations and species hybridizations, and possibly undiscovered species or subspecies.

DDA Impacts

Approximately 160,000 acres of vegetation would be removed for roads, shelters, and other structures as a result of the proposed action. The potential exists for the removal of additional acreage of vegetation for items not accounted for in the above figure, such as for construction roads and material borrow sites. Shadscale, Great Basin sagebrush, and pinyon-juniper woodland, which cover most of the bajadas and valley bottoms in the proposed DDA, are likely to be the vegetation types most affected. Other bajada and valley bottom vegetation types, including alkali sink scrub, desert marsh and spring vegetation, riparian woodland, creosote bush scrub, and wash and arroyo vegetation would also be affected by direct clearing. A simplified vegetation type map for the proposed project area with the full deployment project layout is shown in Figure 4.

Secondary effects to vegetation would result from accelerated wind and water erosion, sedimentation, soil compaction, deposition of excavated material, altered surface water flow patterns, groundwater drawdown and increased fugitive dust. The most significant of these effects are likely to be localized near cleared areas. However, the large number of potentially cleared locations within many hydrologic sub-units will result in the potential for extensive effects. Since secondary effects to vegetation are related to site-specific factors, such as slope, the total area which will be impacted cannot be determined with percision until detailed siting has been performed.

The spread of weedy species will occur when vegetation is disturbed or removed. One alien annual, halogeton (Halogeton glomeratus), is of particular concern because it is poisonous to livestock and has reduced or eliminated grazing in some areas in the Great Basin. Halogeton becomes quickly established after disturbance. The reestablishment of perennial vegetation is thought to be the only effective method of control of this species. After light disturbance, halogeton may be gradually replaced through competition with native shrubs. Under severe or repeated disturbance, halogeton may alter soil chemistry to the point that native vegetation is excluded. Soil modification by halogeton may prevent native species reestablishment for over 50 years.

VEGETATION TYPES

LEGEND

WESTERN FORESTS

- DOUGLAS FIR FOREST *(Pseudotsuga)*
- WESTERN SPRUCE-FIR FOREST *(Picea-Abies)*
- PINE-DOUGLAS FIR FOREST *(Pinus-Pseudotsuga)*
- ARIZONA PINE FOREST *(Pinus)*
- SPRUCE-FIR-DOUGLAS FIR FOREST *(Picea-Abies-Pseudotsuga)*
- GREAT BASIN PINE FOREST *(Pinus)*
- JUNIPER-PINYON WOODLAND *(Juniperus-Pinus)*
- JUNIPER STEPPE WOODLAND *(Juniperus-Artemisia-Agropyron)*

WESTERN SHRUB AND GRASSLAND

- MOUNTAIN MAHOGANY-OAK SCRUB *(Cercocarpus-Quercus)*
- GREAT BASIN SAGEBRUSH *(Artemisia)*
- BLACKBRUSH *(Coleogyne)*
- SALTBUSH-GREASEWOOD *(Atriplex-Sarcobatus)*
- CREOSOTE BUSH *(Larrea)*
- DESERT: VEGETATION LARGELY ABSENT
- ■ *Yucca brevifolia* (JOSHUA TREE)
- ▼ *Juniperus spp.* (JUNIPER, RED CEDAR)
- TULE MARSHES *(Scirpus-Typha)*
- WHEATGRASS-BLUEGRASS *(Agropyron-Poa)*
- ALPINE MEADOWS AND BARREN *(Agrostis, Carex, Festuca, Poa)*
- SAGEBRUSH STEPPE *(Artemisia-Agropyron)*
- GALLETA-THREE AWN SHRUBSTEPPE *(Hilaria-Aristida)*

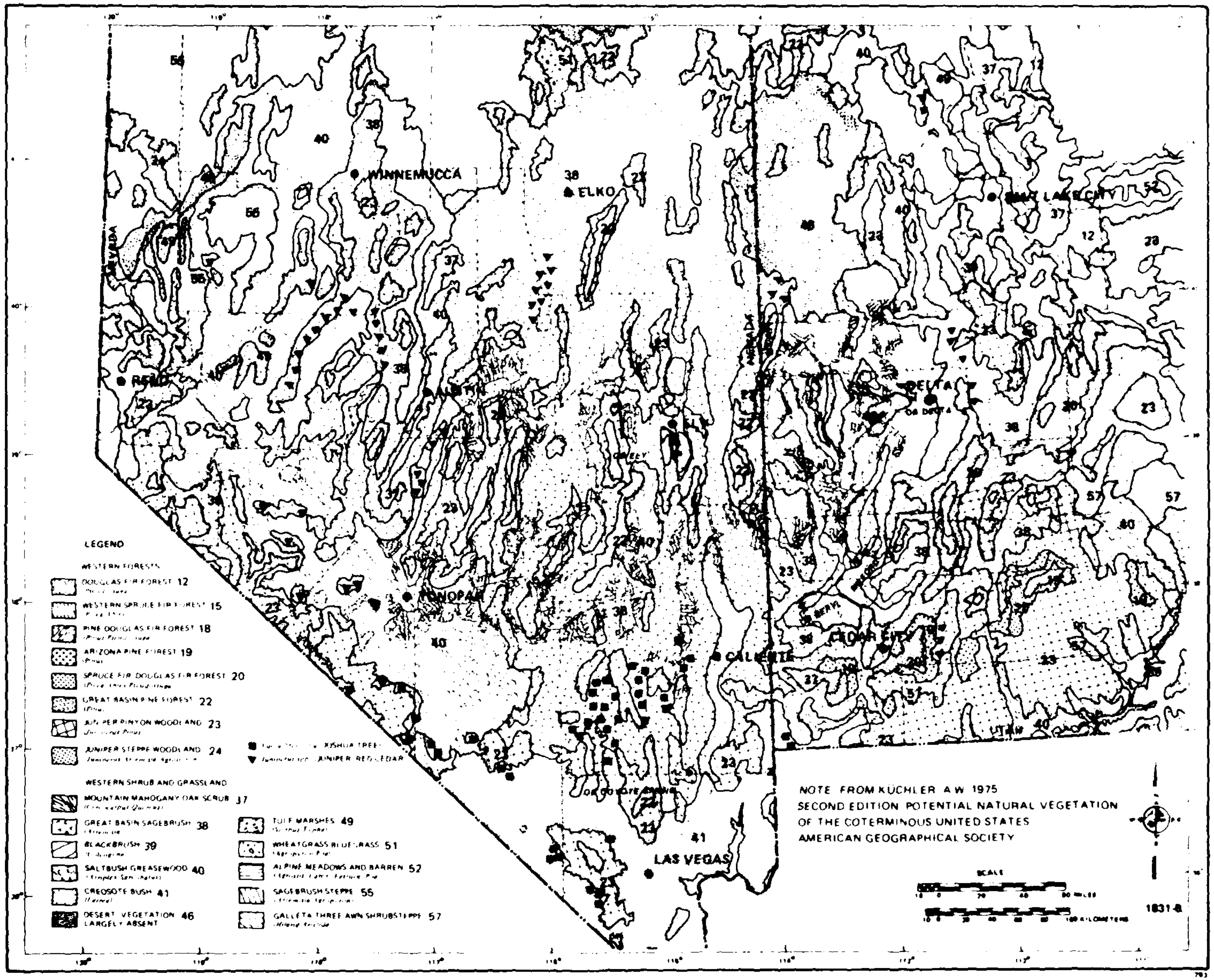

Figure 4. Simplified vegetation type map for Nevada/Utah.

The amount of area cleared of vegetation would increase throughout the construction phase. Additional areas will be disturbed for some time beyond the construction phase as a result of off-road vehicle use and erosion.

Cleared areas which are not used for roads or structures will have the potential for being slowly revegetated. The rate of natural revegetation is dependent upon such factors as the annual rate and seasonal distribution of precipitation, the substrate characteristics, the intensity of erosive forces and the response of reestablishing species to disturbed conditions. Natural revegetation will be inhibited if the soil has been compacted, covered with overburden materials unsuitable for plant growth, or if the surface soil is removed, exposing toxic subsoil, hard soil layers or bedrock.

The time required for the vegetation to recover from disturbance is expected to be very long. Complete recovery may take a century or more. The clearing of vegetation would accelerate the spread of halogeton, a trend that could be irreversible. Long-term establishment of halogeton could prevent reestablishment of native vegetation, and irretrievably degrade the value of the vegetation for future wildlife and livestock use.

Construction and operation of the system would reduce the usefulness of the cleared and surrounding areas for livestock forage, wildlife habitat, and recreation. Many individuals of common animal species which rely on the vegetation would be lost. Although cleared areas would be less than 2 percent of any hydrologic subunit, these areas will be subject to erosion, an impact which is particularly critical when dust, sediment, and flooding impacts nearby streams or rivers, farming operations, or population centers.

The large number of cleared areas in many of the affected hydrologic subunits would result in a greater impact than would occur from the clearing of only a few areas. The opportunity for viewing undisturbed areas would be limited in watersheds with many clusters. The more disturbed area, the larger the amount of vegetation lying around the perimeter of the cleared areas which will be subject to erosion and flooding. These areas would be subject to invasion by toxic weeds would make livestock avoidance more difficult. The proportion of the watershed which lies within 0.5 mi of a disturbance provides a rough index to the frequency of vegetation clearing and the associated secondary impacts. Based on planimetry from 1:250,000 scale maps of the project layout, it was determined that three hydrologic subunits would have over 50 percent of their area within 0.5 mi of disturbance, and an additional 18 hydrologic subunits would have over 25 percent of their area within 0.5 mi of disturbance. If 5 clusters are sited in the Alkali Spring hydrologic subunit, as shown on the conceptual layout, 59 percent of the valley area would lie within 0.5 mi of where vegetation had been removed.

Table 12 lists the directly impacted hydrologic subunits and the amount and principal types of native vegetation which would be removed.

The clearance of vegetation is unavoidable if the system is to be constructed. However, the cleared area can be kept to a minimum, and much of the adverse impacts associated with vegetation clearance can be avoided or reduced in duration through the mitigation measures discussed below. Without mitigation, the significant adverse impacts from vegetation clearing would range from long-term to permanent.

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Table 12. Potential impact to native vegetation in Nevada/Utah DDA for the Proposed Action and Alternatives 1-6, and 8.

HYDROLOGIC SUBUNIT NO.	HYDROLOGIC SUBUNIT NAME	TOTAL HYDROLOGIC SUBUNIT AREA (ACRES)	POTENTIAL NATIVE VEGETATION REMOVED (ACRES)[5]	INDEX TO OFF-SITE DISTURBANCE* (IOSD)	SHORT- AND LONG-TERM IMPACT*
	Subunits with M-X Clusters and DTN				
4	Snake[1,3]	1,728,000	10,800	23	
5	Pine[2]	467,200	4,100	28	
6	White[2]	601,600	4,900	32	
7	Fish Springs[2]	256,000	2,100	33	
8	Dugway	207,200	2,000	37	
9	Government Creek	362,400	600	8	
46	Sevier Desert[1]	1,920,000	5,800	14	
46A	Sevier Desert & Dry Lake[2,3]	620,800	8,100	24	
54	Wah Wah[2]	384,000	5,800	51	
137A	Big Smoky-Tonopah Flat	1,025,900	3,300	22	
139	Kobeh	555,500	5,000	38	
140	Monitor N & S	664,300	4,000	20	
141	Ralston	586,900	6,400	38	
142	Alkali Spring	200,300	3,300	59	
148	Cactus Flat	see Stone Cabin		—	—
149	Stone Cabin[1]	630,400	4,600	28	
151	Antelope	284,200	4,400	44	
154	Newark	512,600	2,400	33	
155	Little Smoky N & S[2]	741,100	5,000	11	
156	Hot Creek[2]	663,000	4,700	28	
170	Penoyer[1]	448,000	3,900	29	
171	Coal[1,3]	294,400	3,800	43	
172	Garden[2]	315,500	3,400	40	
173	Railroad N & S[2]	1,716,300	11,100	20	
174	Jakes	270,100	3,100	35	
175	Long	416,600	1,300	2	
178B	Butte—South	646,400	3,400	18	
179	Steptoe	1,242,900	500	1	
180	Cave[1]	231,700	2,000	28	
181	Dry Lake[1,3]	564,500	6,800	42	
182	Delamar	245,100	2,000	36	
183	Lake[1]	369,300	3,100	35	
184	Spring[1]	1,063,000	1,400	5	
196	Hamlin[1]	264,300	4,100	56	
202	Patterson[2]	266,200	600	15	
207	White River[2]	1,036,800	4,200	17	
208	Pahroc	305,300	300	7	
209	Pahranagat	503,000	600	4	
	Overall DDA	27,781,200	142,900	5	
	Overall DDA for Alternative 8	14,196,800	73,100	5	

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No impact. (No vegetation removed.)

Low impact. (Less than 1,000 acres vegetation removed and an ICSD of 15 or less.)

Moderate impact (1,000-5,000 acres of vegetation removed and an ICSD between 15 and 25 percent.)

High impact. (Over 5,000 acres vegetation removed and an ICSD over 25.)

[1]Affected hydrologic subunits under Alternative 8.

[2]Conceptual location of Area Support Centers (ASCs) for the Proposed Action and Alternatives 1-6.

[3]Conceptual location of Area Support Centers (ASCs) for Alternative 8.

[4]Includes area for DTN, cluster roads, shelters, construction camps and concrete plants.

[5]Index to off-site disturbance equals the percent of the hydrologic subunit within 3 miles of disturbance.

The extent of vegetation clearing would be minimized by consolidation of transportation and communication networks, avoiding the installation of over-sized surface water diversion structures, and by reducing the need for off-road security and maintenance vehicles. By confining vehicles to designated corridors and by minimizing the area disturbed for construction purposes, the total area disturbed would be reduced. The Air Force has been successful in confining construction to designated corridors, as at the Luke-Yuma construction test site. However, a corresponding degree of success will probably be unlikely, due to the magnitude of the project.

Those areas which were cleared or otherwise disturbed, and not used for roads or other facilities, have the potential for being revegetated. Implementing the following components of a revegetation plan, selected on a site-specific basis, would greatly accelerate vegetation recovery, erosion control, and a return of the disturbed land to current use.

- Reapply surface soil when exposed sub-soil is of lower quality. Quality surface soils should be removed from where roads and structures are to be constructed and then applied to revegetation areas.

- Produce a final surface configuration, providing for stable slopes, minimizing run-off and erosion, and increasing water retention.

- Apply and secure mulch (i.e., straw, gravel) for erosion control, water retention, and soil temperature moderation.

- Plant suitable vegetation where precipitation is greater than 6 in. annually, or where irrigation is used, to provide wildlife habitat, erosion control,and livestock forage. In non-irrigated areas receiving 6 to 8 in. of precipitation annually, the success of seeding efforts is expected to be very limited.

- Irrigate planted areas which receive less than 8 in. of precipitation annually, during the critical plant establishment period. Due to the limited water availability within the project area, irrigation priority should be given to large cleared patches (i.e., shelter locations), to steep cut or filled slopes and highly erodible soils, and to disturbed areas near population centers. Planting efforts usually fail in areas which receive less than 8 in. of precipitation annually (which includes roughly 80 percent of the projected disturbed area), unless irrigation is used. Revegetation water is not included in water estimates presented in this report and would increase requirements significantly, although this could be partially offset by reuse of water when possible.

- Minimize repeated disturbance of planted areas (from livestock and ORV activity), until vegetation is adequately reestablished.

- Implement a post construction monitoring program and treat areas requiring additional erosion control, seeding or transplanting, or vegetation management.

These procedures would help minimize or avoid the permanent establishment of toxic weeds. Although cleared areas would be out of production for an initial

period while vegetation is reestablishing, erosion control and the return of wildlife habitat would be taking place. A comprehensive revegetation program would be very expensive.

Operating Base Impacts

Coyote Spring Valley: The proposed siting of an operating base near Coyote Spring Valley would result in the permanent removal of approximately 7,000 acres of native vegetation, mainly creosote bush scrub and Joshua tree woodland, with some desert marsh and spring vegetation, and wash and arroyo vegetation (see Figure 5). Additional areas may also be cleared as a consequence of construction activity. At the present time, the vegetation of Coyote Springs Valley is relatively undisturbed. Peak impacts to native vegetation from the M-X project would occur near the close of the construction period. Indirect impacts are expected to continue to increase somewhat throughout project life.

Recovery of the vegetation in areas which are not permanently covered may commence at the end of construction, providing that soil conditions and water availability are suitable for plant growth. Available data indicate recovery rates for creosate bush scrub are slow, although they have not been precisely determined. A study on the recovery of this community in the northern Mojave Desert showed that 33 years after disturbance, 20 percent of the shrub species had reached predisturbance levels of density and frequency. This study and others suggest that substantial vegetation recovery will not occur within the lifetime of the M-X project. Complete recovery is likely to require a minimum of 100 years.

Indirect impacts to vegetation in Coyote Srings Valley would include degradation of vegetation, mainly creosote bush scrub, Joshua tree woodland, some desert marsh and spring vegetation, and wash and arroyo vegetation, as a result of the effects of fugitive dust, groundwater drawdown, increased collection of certain plant species for commercial purposes, and increased ORV and other recreational usage. The area of vegetation that may be lost or degraded from these activities could be significant. The indirect impacts from recreational activities of the M-X realted population are expected to extend to surrounding areas. These indirect impacts in are expected to be concentrated in Pahranagat, Meadow Valley Wash, Las Vegas, Lower Moapa, Virgin River, Black Mountains, and California Wash hydrologic subunits.

The impacts will not vary greatly if the location of the base is shifted within the suitability zone. However, the proportion of each vegetation type affected may change, and this could cause significant differences in impacts to moisture-requiring vegetation types, including desert marsh and spring vegetation, and wash and arroyo vegetation.

Additional impacts to Coyote Springs Valley and other nearby may result from construction and operation of the Allen-Warner Valley Energy System in Garnet Valley, approximately 10 mi southeast of the proposed operating base site. Workers present during construction, and in smaller numbers during operations, would be expected to carry out some recreational activities in Coyote Spring Valley and other nearby hydrologic subunits, resulting in indirect impacts similar to those discussed for M-X.

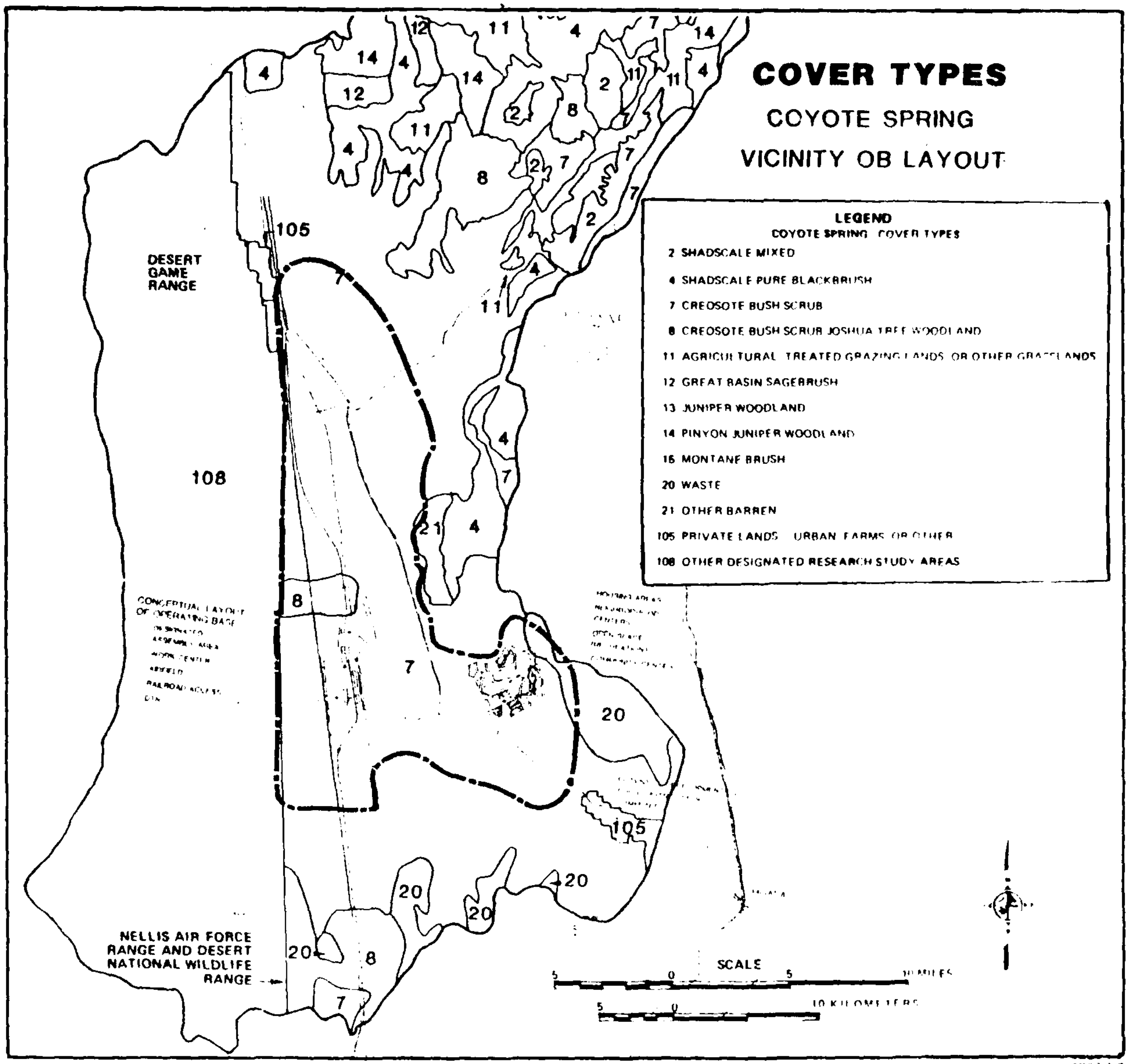

Figure 5. Vegetation cover types in the vicinity of Coyote Spring.

The direct and indirect loss of native vegetation during the construction and operations phases of the project are unavoidable. The amount lost could be reduced by mitigation measures comparable to those discussed for DDA impacts.

Milford, Utah Area: Siting of a second operating base near Milford would result in the direct removal of approximately 5,000 to 5,500 acres of native vegetation, mainly Great Basin sagebrush, shadscale scrub, and alkali sink scrub. Additional acreage of vegetation would also be removed as a result of clearing for drainage diversion, construction marshalling, borrow pit sites, and so forth.

Indirect impacts resulting from recreational activities of the M-X related population are expected to extend to surrounding watersheds with greatest concentration in the Pine, Beaver, Sevier Desert, Parowan, and Beryl-Enterprise District hydrologic subunits, and in the area south of the Beryl-Enterprise District. Indirect impacts will include loss or degradation of Great Basin sagebrush, shadscale scrub, alkali sink scrub, and possibly pinyon-juniper woodland and other vegetation types shown in Figure 6. Another potentially significant adverse impact is the invasion of halogeton (Halogeton glomeratus). Additional indirect impacts to the Milford area and other nearby watersheds may result from an alunite plant about 30 mi southwest of Milford. Construction and operation of the mine and processing plant would result in increased air pollution, and varying degrees of damage to soil, vegetation, and land productivity.

The native vegetation of the Milford area has been affected by livestock grazing and recreational activities. The impacts to vegetation from M-X would not vary greatly if the location of the base is shifted within the suitability zone. However, the proportion of each vegetation type affected may change. For vegetation types of limited occurrence, such as riparian woodland, the amount removed could vary greatly, depending upon the base location selected.

The peak impact level to vegetation from the M-X project would occur near the close of the construction period, although some additional impacts are expected after this period. The long-term and irretrievable loss of native vegetation would be as discussed for the Coyote Spring site.

The direct and indirect loss of native vegetation during the construction and operations phase of the project is unavoidable. The amount of vegetation removed could be reduced by the use of mitigation measures discussed for the DDA.

Alternative 1

DDA Impacts: Impacts would be the same as for the Proposed Action.

Coyote Spring Valley, Nevada Area: Impacts would be the same as for the Proposed Action.

Beryl, Utah Area: The proposed siting of a second operating base near Beryl would result in the direct removal of approximately 5,000-5,500 acres of native vegetation, mainly Great Basin sagebrush, shadscale scrub, alkali sink scrub, and pinyon-juniper woodland (see Figure 7). There is no significant difference anticipated in amount of native vegetation that would be permanently lost at Beryl,

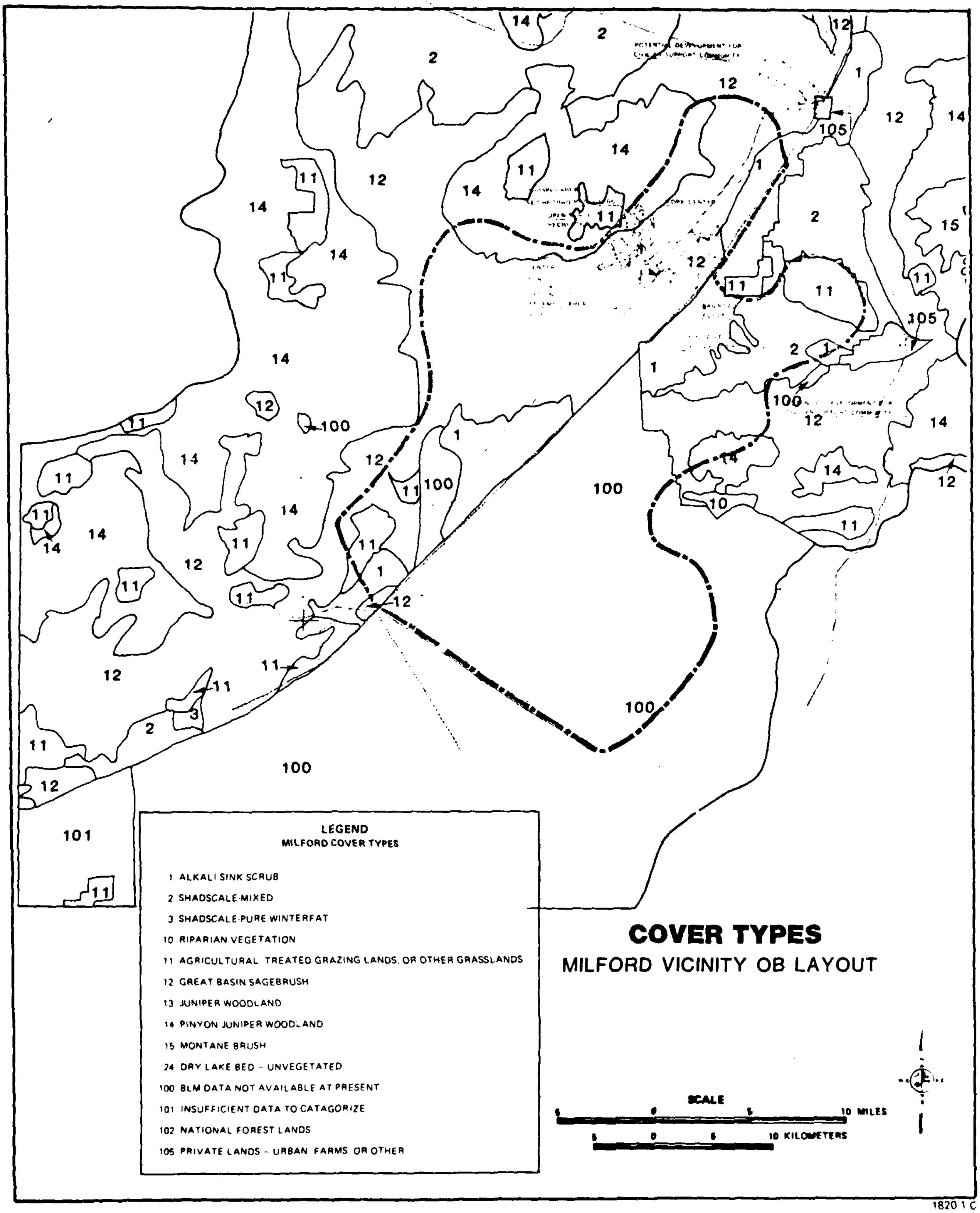

Figure 6. Vegetation cover types in the vicinity of Milford.

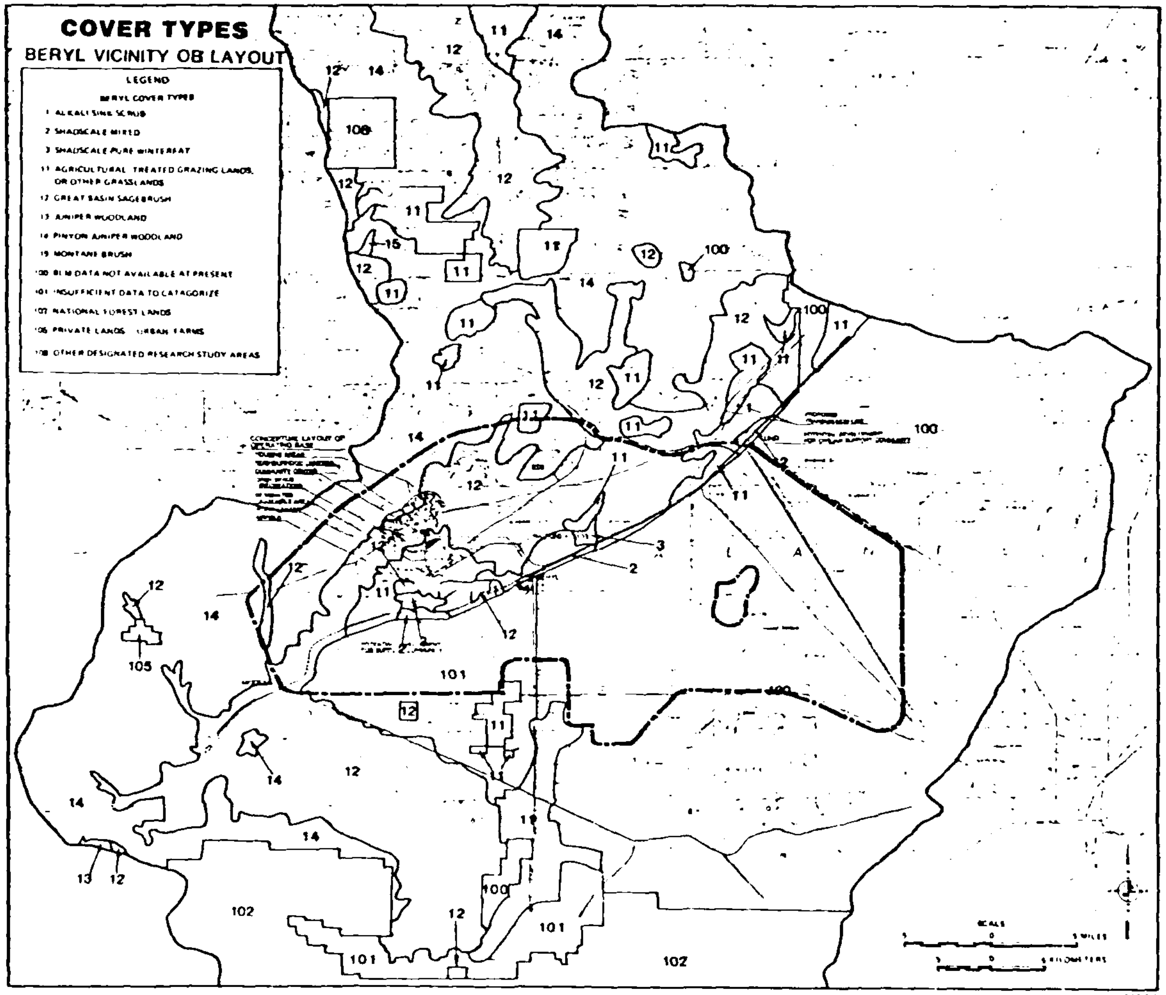

Figure 7. Vegetation types in the vicinity of Beryl.

compared with that lost at Milford. The proportion of each native vegetation type lost would differ between the two sites.

Indirect impacts resulting from recreational activities of the M-X related population are expected to extend to Pine, Cedar City, Parowan, Spring, and Eagle valleys and the area south of the Beryl-Enterprise District.

The impacts will not vary greatly if the location of the base is shifted within the suitability zone. The proportion of each vegetation type affected may change. For vegetation types of limited area, for example, pure winterfat stands, the amount lost within the suitability zone could vary greatly, depending on the location selected.

Alternative 2

DDA Impacts: Impacts would be the same as for the Proposed Action.

Coyote Spring Valley, Nevada Area: Impacts would be the same as for the Proposed Action.

Delta, Utah Area: The proposed siting of a second operating base near Delta would result in the direct removal of approximately 5,000-5,500 acres of native vegetation, mainly shadscale scrub and some alkali sink scrub, from construction of permanent facilities (see Figure 8). This impact is not significantly different from that expected from the proposed action of siting an operating base near Milford. The effects on native vegetation from temporary removal and indirect impacts are also expected to be similar to those of the proposed action. The loss of shadscale scrub may be greater at Delta than at Milford, since larger areas of this vegetation type are found at Delta.

Indirect impacts resulting from recreational activities of the M-X-related population are expected to be concentrated in Beaver, Fish Springs, Government Creek, and Rush valleys, and in the area east of the Sevier Desert.

The impacts will not vary greatly if the location of the base is shifted within the suitability zone.

Additional impacts to the native vegetation of the Delta area and other nearby hydrologic subunits may result from construction of the Intermountain Power Project near Lynndyl, 15 mi northeast of Delta. Impacts to vegetation from this project include permanent removal of 2,650 acres and temporary removal of an addditional 8,320 acreas of vegetation. Indirect impacts to vegetation are also expected from the IPP project.

The changes in impacts over time, the long-term and irretrievable losses of native vegetation, the significance of the impacts and potential mitigation measures are expected to be similar to those discussed for the Milford Base of the Proposed Action.

Alternative 3

DDA Impacts: Impacts would be the same as for the Proposed Action.

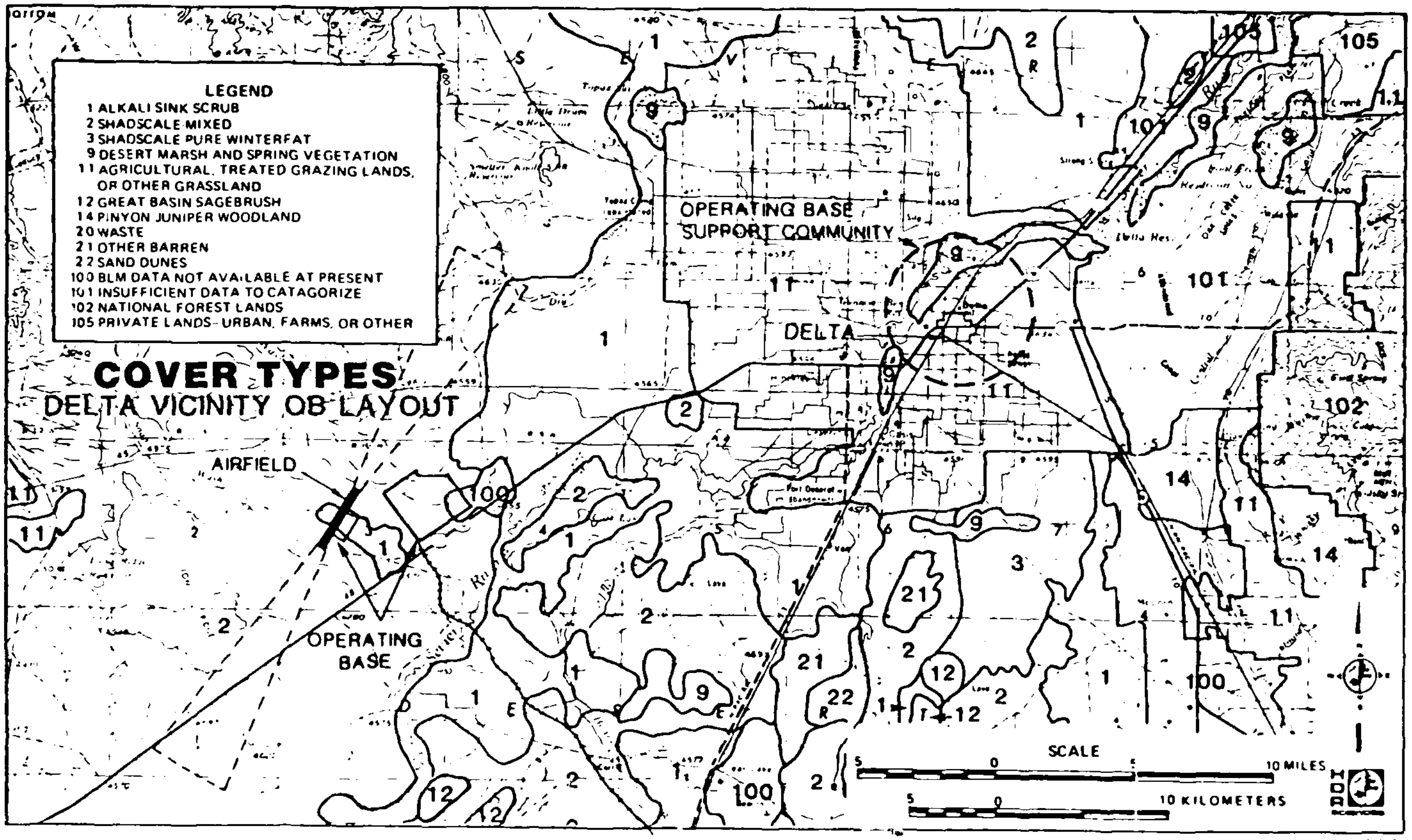

Figure 8. Vegetation cover types in the vicinity of Delta

Beryl, Utah Area: Impacts would be the same as those are discussed under Alternative 1, for Beryl as a second base, except that an additional 2,000 acres of vegetation would be removed. In addition, indirect impacts would be greater, since there will be a larger M-X-related population at the first base than at the second base.

Ely, Nevada Area: Siting the second operating base near Ely would result in the direct removal of approximately 5,000-5,500 acres of native vegetation, mainly Great Basin sagebrush and pinyon-juniper woodland (see Figure 9). This impact is not significantly different from that expected as a result of siting a second operating base near Milford, the proposed action. Temporary and indirect impacts to vegetation are expected to be similar to those of the proposed action.

Indirect impacts resulting from recreational activities of the M-X-related population are expected to be concentrated in Spring, White River, Ruby, Jakes, and Snake hydrologic subunits. The impacts would not vary greatly as the location of the base was shifted within the suitability zone.

Additional impacts to the native vegetation of the Ely area and other nearby watersheds are expected from the planned reopening of the Kennecott Copper Mine, north of Ely, and the construction and operation of the White Pine County Power Plant. Expected impacts on vegetation from the reopening of the Kennecott Copper Mine include those resulting from increased local population level. Potential sites for the White Pine County Power Plant include one in Jakes Valley, west of Ely, and another one near McGill in northern Steptoe Valley. Both of these are near the proposed operating base site south of Ely. White Pine Power is expected to result in some permanent loss of native vegetation, and additional indirect impacts. The change in impact over time, the long-term and irretrievable losses of native vegetation, the significance of the impacts and the potential mitigations are similar to those discussed for the second base of the proposed action.

Alternative 4

DDA Impacts: Impacts would be the same as for the proposed Action.

Beryl, Utah Area: Impacts would be the same as they would be under Alternative 3.

Coyote Spring Valley, Nevada Area: Impacts would be similar to those discussed under the Proposed Action, except 2,000 fewer acres of vegetation would be removed, and indirect impacts would be less extensive.

Alternative 5

DDA Impacts: Impacts would be the same as those for the Proposed Action.

Milford, Utah Area: Impacts would be similar to those discussed for the Proposed Action, except approximately 2,000 more acres of native vegetation would be removed. In addition, indirect impacts would be greater, since there would be more people.

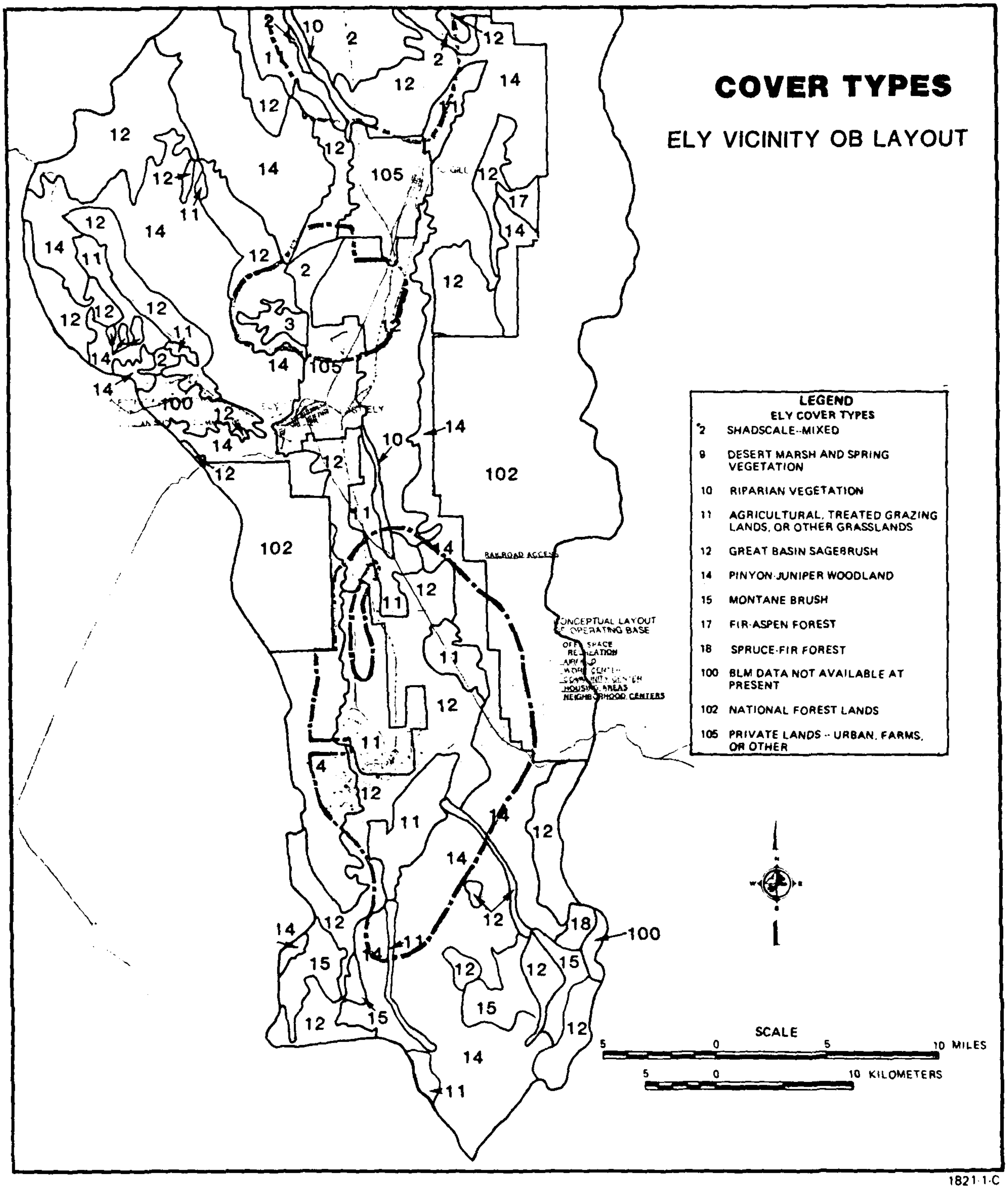

Figure 9. Vegetation cover types in vicinity of Ely

Ely, Nevada Area: Impacts would be the same as they would be under Alternative 4.

Alternative 6

DDA Impacts: Impacts would be the same as for the Proposed Action.

Milford, Utah Area: Impacts would be the same as they would be for Alternative 5.

Coyote Spring Valley, Nevada Area: Impacts would be the same as they would be for Alternative 4.

Alternative 7

DDA Impacts: Full deployment in Texas and New Mexico would primarily affect cropland and intensively grazed rangeland. The affected area of relatively undisturbed native vegetation would be small. The acreage of undisturbed native vegetation which would be cleared is not known because this vegetation exists in small patches between cropland and rangeland. An estimated 75,000 acres of rangeland would be removed. Grama, bluestem, and mesquite grasslands would be the most extensively impacted vegetation types. A simplified vegetation type map for the Texas/New Mexico project area with the alternative full deployment layout is shown in Figure 10. Secondary effects to vegetation would be of a smaller magnitude than those discussed for the proposed action. Impact changes occuring over time are discussed under the Proposed Action.

Those areas which are used for roads and structures would be permanently lost from vegetation reestablishment and from uses which rely on the vegetation. Cleared areas which are not used for roads or structures will have the potential for being revegetated. The rate of natural revegetation is dependent upon such factors as the annual rate and seasonal distribution of the precipitation, the substrate characteristics, the intensity of erosive forces, and the response of reestablishing species to disturbed conditions. Natural revegetation will be inhibited if the soil has been compacted, covered with over-burden materials unsuitable for plant growth, or if the surface soil is removed. If a suitable substrate remains after construction activities, partial vegetation recovery can be expected from natural processes within a few years after the end of construction.

Construction and operation of the system would reduce the usefulness of the cleared and surrounding areas, which supported native vegetation, for livestock forage, wildlife habitat, and recreation. Many individuals of common animals which rely on the vegetation would be lost. The disturbed areas would be subject to erosion, and resulting impacts to nearby streams or rivers, farming operations, or population centers.

The area of native vegetation cleared would be significantly less than for the Proposed Action (because there is less native vegetation remaining in Texas/New Mexico than in Nevada/Utah), and the recovery of the native vegetation would proceed more rapidly. Table 13 lists the directly impacted counties and the estimated acreage of native vegetation which would be removed.

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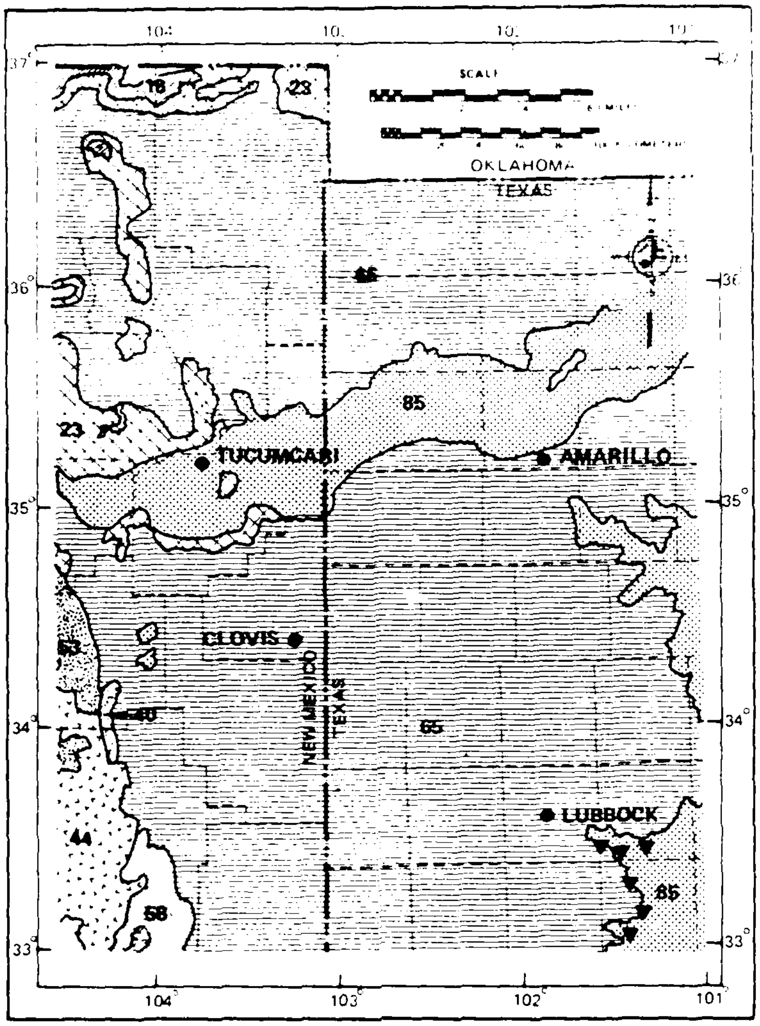

LEGEND

WESTERN FORESTS

PINE-DOUGLAS FIR FOREST 18
Pinus-Pseudotsuga

JUNIPER-PINYON WOODLAND 23
Juniperus-Pinus

WESTERN SHRUB AND GRASSLAND

SALTBUSH GREASEWOOD 40
Atriplex-Sarcobatus

CREOSOTE BUSH-TARBUSH 44
Larrea-Flourensia

▼ *Yucca brevifolia* (JOSHUA TREE)

GRAMA-GALLETA STEPPE 53
(*Bouteloua-Hilaria*)

GRAMA-TOBOSA SHRUBSTEPPE 58
(*Bouteloua-Hilaria-Larrea*)

CENTRAL AND EASTERN GRASSLANDS

GRAMA-BUFFALO GRASS 65
(*Bouteloua-Buchloe*)

MESQUITE BUFFALO GRASS 85
(*Prosopis-Buchloe*)

NOTE: FROM KUCHLER, A.W. 1975
SECOND EDITION, POTENTIAL NATURAL VEGETATION
OF THE COTERMINOUS UNITED STATES
AMERICAN GEOGRAPHICAL SOCIETY

Figure 10. Simplified vegetation type map for Texas/New Mexico showing project layout.

Table 13. Potential impact to native vegetation in Texas/New Mexico for Alternatives 7 and 8.

COUNTY	COUNTY AREA (ACRES)	AREA WHICH WOULD BE DISTURBED (ACRES)	POTENTIAL NATIVE VEGETATION REMOVED[5]	SHORT- AND LONG-TERM IMPACT[1]
Counties with M-X Clusters and DTN				
Bailey, TX[2]	534,400	3,500	500	
Castro, TX	563,200	3,900	200	
Cochran, TX[2]	500,800	2,400	500	
Dallam, TX	945,200	20,000	6,800	
Deaf Smith, TX[3,2]	966,400	16,400	3,900	
Hartley, TX[3,2]	952,300	10,700	8,200	
Hockley, TX[2]	see Lamb Co.			
Lamb, TX[2]	654,100	2,200	0	
Oldham, TX[2]	945,300	1,800	100	
Parmer, TX[2]	549,800	7,000	600	
Randall, TX	584,000	1,300	600	
Sherman, TX	586,200	700	300	
Swisher, TX	see Castro Co.			
Chaves, NM[2]	389,400	13,700	13,600	
Curry, NM[3,2]	897,900	7,800	2,800	
DeBaca, NM[2]	1,507,800	1,300	1,300	
Guadalupe, NM[2]	see Quay Co.			
Harding, NM[2]	1,365,400	4,900	4,800	
Lea, NM[2]	2,811,200	900	700	
Quay, NM[4,2]	1,840,000	14,500	10,300	
Roosevelt, NM[3,4,2]	1,570,800	18,500	14,200	
Union, NM[2]	2,442,200	6,500	4,600	
Overall DDA for Alternative 7		138,000	74,000	
Overall DDA for Alternative 8		70,000	48,600	

3875-1

[1] No impact. (No vegetation removed.)

Low impact. (Less than 1,000 acres vegetation removed.)

Moderate impact. (Between 1,000 and 5,000 acres vegetation removed.)

High impact. (Greater than 5,000 acres vegetation removed.

[2]Affected counties under Alternative 8.

[3]Conceptual location of Area Support Centers (ASCs) for Alternative 7.

[4]Conceptual location of Area Support Centers (ASCs) for Alternative 8.

[5]Includes area for DTN, cluster roads, shelters, construction camps and concrete plants and is based on LANDSAT analysis.

The clearance of vegetation is unavoidable if the system is to be constructed. However, the cleared area can be kept to a minimum, and much of the adverse impacts associated with vegetation clearance could be avoided through mitigation measures. Without mitigation, the significant adverse impacts from vegetation clearing would range from short-term to permanent.

The implementation of a comprehensive revegetation program for the Texas/-New Mexico full deployment alternative would cost significantly less than anticipated for the proposed project. Revegetation in the Texas/New Mexico deployment area would not require significant quantities of irrigation water compared to the Proposed Action.

Clovis, New Mexico Area: LANDSAT imagery analysis shows that virtually all the land in the vicinity of Clovis is agricultural, so no native vegetation will be removed directly as a result of siting the first operating base near Clovis. The nearest extensive area of native vegetation is located 25 mi north, in the Canadian Breaks area.

Dalhart, Texas Area: LANDSAT imagery shows that essentially all the land in the vicinity of Dalhart is agricultural, so no native vegetation will be removed directly as a result of siting the second operating base in Dalhart.

Alternative 8

DDA Impacts: The Alternative 8 layout for split basing would result in the removal of vegetation from approximately 85,000 acres in the Nevada/Utah project area and 50,000 acres in the Texas/New Mexico project area. The impacts to native vegetation in the Nevada/Utah project area would be reduced roughly 50 percent compared to the proposed project. In Nevada, a proportionately greater amount of the shadscale scrub vegetation type would be cleared due to the elimination of clusters within hydrologic subunits including Kobeh and Antelope valleys, which are predominantly covered by sagebrush. In Utah, hydrologic subunits which are predominantly covered by alkali sink scrub and shadscale scrub vegetation types, including Fish Springs and White valleys, have been eliminated.

This split basing alternative shifts one half of the project layout away from relatively undisturbed native vegetation (in Nevada and Utah) and into rangeland and cropland in Texas and New Mexico. Therefore, a less significant impact to relatively undisturbed native vegetation would occur from this split basing alternative compared to the Proposed Action. Due to the higher levels of precipitation and the generally more favorable soil conditions encountered in Texas and New Mexico, natural revegetation can be expected to proceed more rapidly for this half of the project layout. The implementation of a revegetation plan for the Texas/New Mexico portion of the split basing layout would be less expensive than the proposed action and would not require significant quantities of irrigation water.

Coyote Spring Valley, Nevada Area: Impacts would be the same as those discussed for the Proposed Action.

Clovis New Mexico Area: Impacts would be the same as those discussed for Alternative 7.

FUTURE TRENDS WITHOUT PROJECT

Without the deployment of M-X in the Nevada/Utah project area, a continued, gradual loss and degradation of native vegetation is anticipated. This trend is expected as a result of energy resource development, expansion of existing towns, increases in recreation, greater use of water resources, and continued overgrazing by domestic livestock and wild horses in certain locations.

The development of energy resources in the project area, including minerals, oil and gas, geothermal power, and solar power, has been increasing. The power development projects will supply primarily large metropolitan areas outside the M-X study area (e.g., Los Angeles, Phoenix). Power producing facilities currently scheduled to be built in the project area include the Intermountain Power Project (IPP) near Delta, Utah, the White Pine Power Plant in White Pine County, Nevada and part of the Warner-Allen project, between Las Vegas and Caliente, Nevada. Exploration for new mineral leases is underway and there are plans to reopen some existing mines. A large molybdenum mine is being developed near Tonopah, Nevada. An alunite plant is planned near Milford. The reopening of the Kennecott Copper mine north of Ely is currently being considered. Experiments with geothermal power are under way in the Escalante Desert in Utah, and widespread testing for oil and gas is in progress. These projects will result in the removal and degradation of natural vegetation. Vegetation degradation will be caused by air pollution, flooding, sedimentation, accelerated erosion, altered water flow patterns, and groundwater drawdown.

A loss of native vegetation is expected to result from the projected population increases in the Nevada/Utah project area. Current trends in permanent population indicate a moderate to large growth of metropolitan areas, moderate growth of small towns, and limited increase or decline of the population in remote regions. Population increases affect vegetation in a variety of ways. The construction of new homes and other facilities needed to serve the population results in removal of native vegetation and the degradation of vegetation in nearby areas. An increase in recreational use of certain areas, especially by off-road vehicles, will cause further degradation of native plant communities. Another effect of increased population levels is increased poaching of cacti, other succulents, and yucca for landscaping and personal collections.

In the Nevada/Utah study area the spread of weedy species, especially alien annuals, will continue to occur as vegetation is disturbed by construction, overgrazing, and recreational activities. The continued spread of halogeton is of particular concern because it is poisonous to livestock and it can alter soil conditions sufficiently to prevent return of native perennial vegetation (Eckert and Kinsinger, 1960).

In the Texas/New Mexico study area, no change is expected in the status of undisturbed native vegetation, which exists only as small patches scattered throughout rangeland and farmland, without M-X deployment. Population growth estimates of 1.5 percent per year, concentrated in the larger towns, makes significant loss of undisturbed native vegetation unlikely. Potential changes in land use, primarily from irrigated to dryland farming (due to aquifer overdrafts), should not affect the native vegetation. No major projects involving extensive land use (other than M-X) are planned for the region.

APPENDIX A

The Spread of Halogeton
as an Anticipated Result
of M-X System Construction

Livestock poisoning from toxic weeds on western ranges has been documented for over 70 years. Heavy cattle and sheep losses have been reported from consumption of larkspur (Delphinium spp.), locoweed (Astragalus spp.), greasewood (Sarcobatus vermiculatus), and lupine (Lupinus spp.), (Couch, 1937; Marsh et al., 1913; Stoddart et al., 1949). Halogeton is another poisonous species found on the western ranges. This annual herb was introduced into the United States from Siberia about 50 years ago and has now spread over most of Nevada, and portions of Utah and other western states (U.S. Dept. of Agriculture, 1970).

Halogeton rapidly invades disturbed areas where the soil has been disturbed or where the native plant cover has been degraded (Cook and Stoddart, 1954). Halogeton is found on saline soil in areas which receive from 3 to 20 in. of percipitation annually and at elevations up to 7,000 ft. Dense, localized stands of halogeton are found along the roads, sheep driveways, abandoned fields, and other areas where the native vegetation has been removed or severely degraded. A detailed distribution of this species, together with its specific climate and edaphic limits, has not been documented.

Numerous, large sheep losses have been reported from the consumption of halogeton. The loss of 750 sheep from a single flock has been reported (Twin Falls Times-News, 1945). Force-feeding trials have demonstrated that high doses of halogeton (½ - 1½ lbs) causes a loss of alertness and a lack of coordination, followed by coma and death (Cook and Stoddart, 1953). These results were attributed to soluble oxalates as the poisonous element. The adverse effects of halogeton consumption to sheep are of great concern, in that the M-X deployment area contains an estimated 377,000 sheep grazing on federal rangelands, as compared to 118,000 cattle (Resource Concepts, Inc., 1980).

No losses of cattle have been attributed to halogeton consumption. Apparently, cattle dislike halogeton and consume it only sparsely. Sublethal effects of halogeton on cattle may occur, but have not been investigated.

COMPARISON OF CURRENT AND ANTICIPATED (POST-M-X) HALOGETON DISTRIBUTION

Halogeton has gained a permanent foothold in disturbed areas within the potential M-X deployment area. It is found in localized, dense stands, along roads and trails, in the vicinity of the livestock watering sites, and in some areas which were extensively overgrazed. The localized distribution of halogeton results from the ability of undisturbed native perennial vegetation to exclude it. Numerous extensive areas, within most hydrologic subunits are currently free of dense

halogeton stands. A few, large areas contain dense halogeton stands where extensive overgrazing has occurred in the past. One example is Wah Wah Valley in which much of the valley bottom is infested with halogeton.

The construction of roads, shelters and other facilities for the M-X system would result in a network of disturbed areas throughout most of the deployment area. An examination of halogeton's local distribution and its edaphic and climatic tolerance would be necessary to precisely delineate areas susceptible to halogeton invasion. An estimated 160,000 acres in Nevada and Utah would be cleared for construction of the system and a substantial portion of this would be subject to halogeton establishment. Additional acreage is likely to be cleared for items not accounted for in the above figure. In addition to cleared areas, vegetation degradation would occur in many near-by locations from wind and water erosion, sedimentation, soil compaction, deposition of excavated materials, altered surface water flow patterns, groundwater drawndown, and off-road vehicle use. Additional vegetation clearing and degradation would occur from activities associated with M-X-stimulated population growth, such as community expansion and increased recreational activities. Most of the disturbed areas (which are not covered by permanent facilities) will be subject to dense halogeton infestation. After M-X system construction, areas remaining free of dense halogeton stands would be greatly reduced in size. Figures 11 and 12 show the areas subject to establishment of dense halogeton stands in a hypothetical watershed, before and after M-X system construction.

ANTICIPATED IMPACTS OF INCREASED HALOGETON STANDS ON THE LIVESTOCK INDUSTRY

An obvious impact of increased halogeton stands on the livestock industry would be the death of grazing animals. Other less obvious adverse effects would occur. Ingestion of non-lethal quantities of poisonous weeds has been shown to produce detrimental effects such as reduced weight gain, reduced birthrate, and deformed young (Nielson, 1978).

The increased presence of halogeton would alter the way in which existing rangeland is used. Both the type of livestock and the seasonality of range use are likely to require adjustment, with a possible reduction in the efficiency of use and the returns from those rangelands (Neilsen, 1978). Greater costs resulting from the increased presence of halogeton would include those costs for noxious weed control, fencing, more extensive livestock management, and a loss of grazable land in the more heavily infested areas. These costs are likely to exceed the monetary value of the livestock losses (Krueger and Sharp, 1978). The reduced size of undisturbed areas within the deployment area would require more frequent herd movements and the spatial frequency of dense halogeton stands would make those herd movements more complicated (see Figure 11).

As a result of halogeton establishment, land in the vicinity of cleared locations could have a substantially reduced value as livestock range. This would occur because (1) these areas would be subject to halogeton infestations as a result of indirect impacts discussed above and (2) it would be very difficult to control livestock movements in these areas in order to prevent grazing on adjacent cleared areas which support dense halogeton stands. This second point would be particularly critical during years when low rainfall has resulted in below normal quantities of

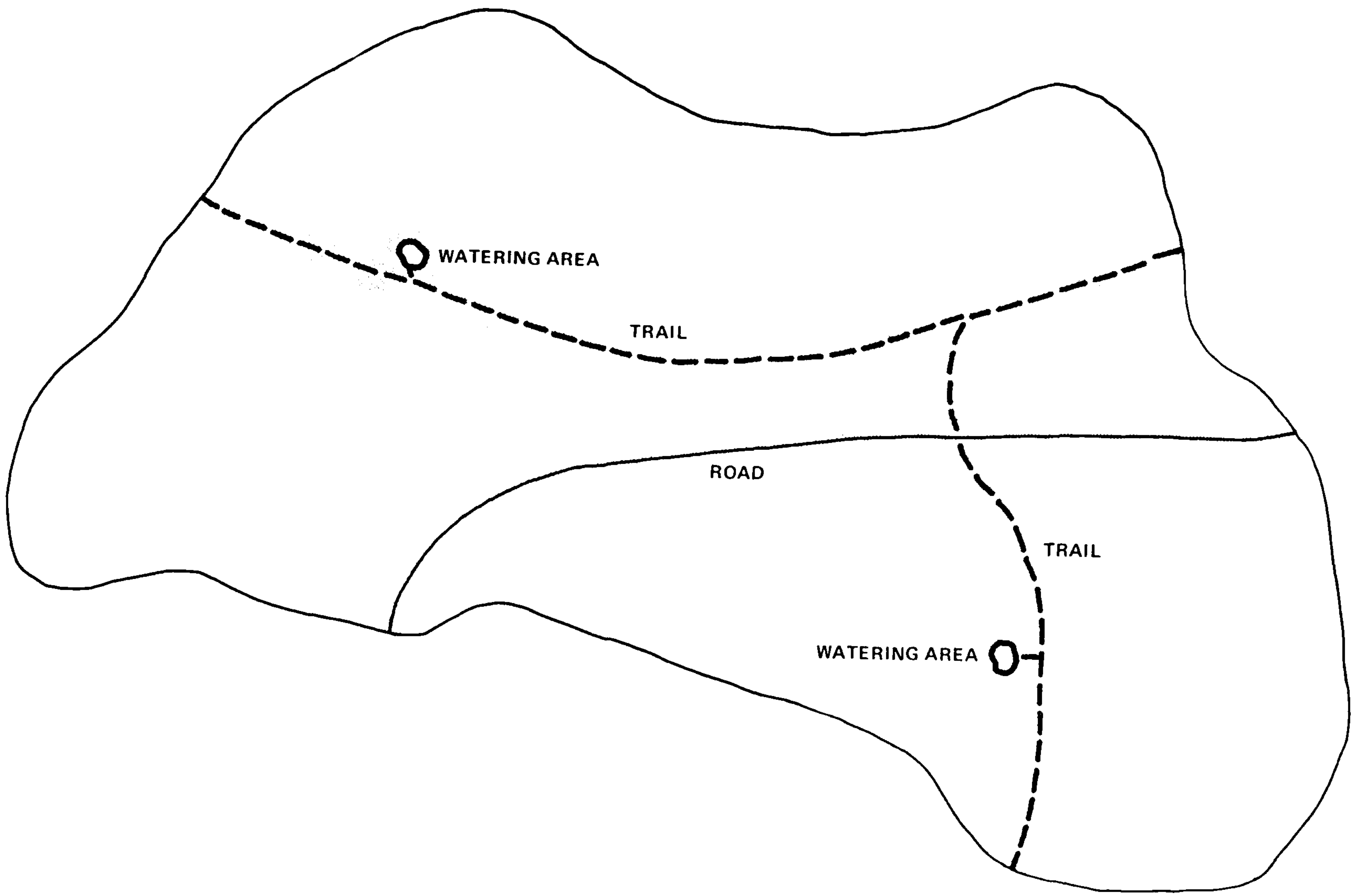

Figure 11. Hypothetical valley showing areas subject to the establishment of dense halogeton stands prior to construction of the M-X system. 3362-A

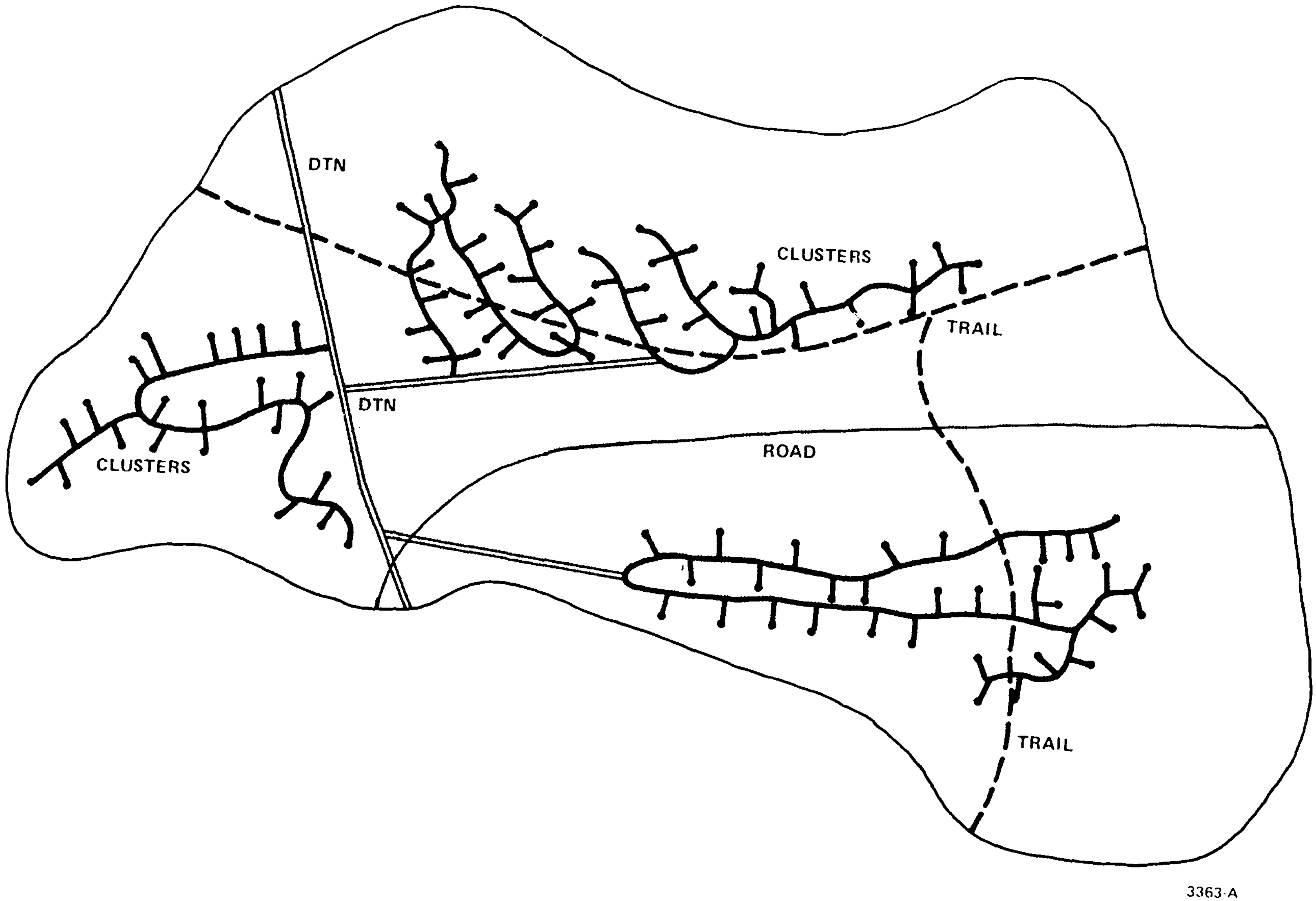

Figure 12. Hypothetical valley showing areas subject to the establishment of dense halogeton stands after construction of the M-X system.

preferrred forage, making consumption of lethal doses of halogeton more likely. A distance of up to 0.5 mile from cleared locations was used as an estimate of the area of reduced value as livestock range. Using this estimate, it was determined that 20 of the 37 hydrologic subunits in the deployment area would have over one-fourth of their area within this category of reduced value. Three of the hydrologic subunits, Wah Wah Valley, Alkali Springs Valley, and Hamblin Valley, would have over one-half of their area in this category.

CONTROL OF HALOGETON

Mechanical removal and the use of herbicides have been found to be ineffective in controlling halogeton. Although both mechanical and chemical methods initially remove halogeton stands, the species rapidly reinvades. Reinvasion by the species is aided by the enormous number of seeds produced by the species (up to ½ billion seeds per acre of halogeton), the rapid seed dispersion by wind and animals, and the ability of the seeds to germinate from early spring through the summer (Cleaves and Taylor, 1979; Cook and Stoddart, 1953). Both tillage and chemical spraying removes native vegetation along with halogeton making additional space subject to halogeton infestation. Short-term halogeton control with chemical sprays or tillage, although expensive, may be useful in strategic locations where livestock are held in large numbers.

The reestablishment of perennial vegetation has been found to be a successful method to control halogeton. Competition from native and introduced perennial species has been shown to effectively reduce or exclude halogeton from many range sites. Halogeton infestations have been shown to be inversely related to the density of other plants (Cronin, 1973). A five percent cover of Fairway wheatgrass (Agropyron cristatum) and Russian wildrye (Elymus junceus) was sufficient to totally exclude halogeton (Miller, 1956). A 22 percent cover of native shrubs was also shown to exclude halogeton entirely. The reestablishment of native shrubs on a surface mined site has been shown to reduce halogeton production by 40 percent (Cleaves and Taylor, 1979). These studies have demonstrated that halogeton control can be accomplished through the reestablishment of perennial vegetation and that this method may be the only effective way for permanent control of the toxic weed.

The natural reestablishment of vegetation on most areas cleared for M-X system construction is projected to take from decades to centuries. Halogeton is likely to persist in cleared areas until a sufficient cover of perennial vegetation has reestablished to out-compete the halogeton. Sediment and runoff from areas cleared of vegetation will deteriorate adjacent land and create additional space for halogeton infestation. Repeated disturbance of cleared areas from livestock grazing, ORV use and from other activities, will prevent vegetation reestablishment and thereby contribute to long-term persistence of halogeton.

Eckert and Kinsinger (1960) found that leachate from halogeton increases soil pH and salinity and decreases the rate of water percolation into the soil. The modification of the soil by halogeton is thought to afford a competitive advantage to the species and may inhibit reestablishment of other plants (Kinsinger and Eckert, 1960).

The implementation of a revegetation program which would restrict or exclude halogeton from disturbed areas would be expensive (ranging from a few hundred to a

few thousand dollars per acre) and could include the use of significantly more water than is included in current plans. The replacement of surface soils, the planting of adapted species, the use of mulches and irrigation, and the temporary restriction of off-road vehicle use and livestock use of recovering areas would be necessary in many cleared locations to achieve adequate plant establishment for the control of halogeton.

APPENDIX B

Soil Handling Procedures to Maximize
Revegetation Potential in the
Nevada/Utah Candidate Siting Region
for the M-X Missile System

The construction of M-X missile system would result in soil disturbances ranging from surface soil compaction to overburden excavation. Construction activities which would entail the greatest soil and overburden disruption include the excavation for (1) missile shelters, (2) borrow pits and quarries, (3) roadways, and (4) building foundations. Numerous other activities such as trenching for diversion structures, and the clearing of vegetation for construction staging areas, haul roads and support facility perimeters, may disturb only surface soils. The long-term loss of native vegetation resulting from M-X system construction could be minimized by the revegetation of disturbed areas not covered by paved roads or structures.

MINIMIZING THE LEVEL OF SOIL DISTURBANCE

For the majority of sites in the Nevada/Utah candidate siting region, procedures which keep soil disturbance to a minimum would enhance the potential for vegetation reestablishment. When only minor surface disturbances occur, leaving root system intact, many native shrubs and grasses will revegetate quickly by root sprouting (Institute for Land Rehabilitation, 1979; Jaynes and Harper, 1978; Young and Evans, 1974). Large seed reserves are found at shallow depths in desert soils (Goodall and Morgan, 1974; Nelson and Chew, 1979) and vegetative propagules are contained in disturbed surface soils. These propagules would contribute to site revegetation if soil disturbance does not result in their burial to a depth which inhibits emergence (Beauchamp et al., 1975; Howard and Samuel, 1979; Redente et al., 1980).

Past studies have suggested that superficially disturbed areas revegetate more rapidly because of their similarity to naturally disturbed areas, such as desert washes. Vasek and others (1975) found that wash inhabiting species of creosote bush scrub vegetation are slightly more abundant and cover more ground on scraped areas than on a more severely disturbed trenched area. Wells (1961) found shrubs, which are characteristic of desert washes, established on Nevada ghost town streets which had been unpaved and ungraded. As the level of soil disturbance increases, the establishment of weedy exotic species has been found to increase (Eckert and Kinsinger, 1960). A decrease in mycorrhizal infection potential from increased levels of disturbance (Miller, 1979; Redente et al., 1980), is one of many factors thought to give non-mycorrhizal exotic species a competitive advantage over mycorrhizal native species.

The operation of construction vehicles will cause increased bulk density of surface soils as a result of soil compaction. The productivity of remaining vegetation and the reestablishment of vegetation will be inhibited in compacted locations due to restricted root penetration, soil aeration, and water infiltration. The degree of soil compaction and the associated adverse affects on plants would be minimized through the use of construction equipment with low (weight to surface area) bearing ratios and by restricting multiple passes over a given location.

PRE-CONSTRUCTION SOIL CHARACTERIZATION

In locations where soil or overburden materials would be disturbed, detailed characterization of these materials is required in order to plan soil handling procedures which provide the greatest revegetation potential. The soil profile and underlying materials (to the depth of anticipated disturbance) would need to be described and mapped (Wyoming Department of Environmental Quality, 1978). In locations where only surface soil disturbance is anticipated, characterization of the soil profile to a depth of 60 in. (or to bedrock if less than 60 in.) would be valuable for the development of revegetation strategies. The required sampling frequency would depend on special variability of the soils. Mapping of soils at Order I detail (1:10,000 scale) or greater may be required to properly identify locations having high quality surface soil (Schafer, 1979). The characterization of soil horizons and overburden for the following parameters would provide useful information for rating cover-soil quality:

Electrical Conductance of Soil Extract (EC)
pH of Soil Paste
Saturation Percentage
Particle Size Analysis
Sodium Absorption Ratio (SAR)
Organic Carbon
Exchangeable Sodium Percentage (ESP)
Acid Base Potential
Coarse Fragment Content
Available Water Holding Capacity
Permeability
Extractable NO_3-N, P, K, Ca, Mg, Na, Se, B, Mo, Pb, As, Cd, Cu, Fe, Mn, and Zn

Analysis for EC, Na, Ca, Mg, SAR, and texture are particularly valuable for the development of soil handling procedures. Appropriate analytical methods for soil and overburden materials are presented by Richards (1969), Sandoval and Power (1977), Sobek and others (1978), and the Soil Conservation Service (1972).

Using the soil analysis results, the soil horizons and overburden layers can be categorized as to their quality for use as cover-soil. Schafer (1979) presents the National Cooperative Soil Survey proposed guidelines for estimating cover-soil quality. Topsoil or subsoil with an EC greater than 8 mmhos/cm, an ESP greater than 15, and with coarse fragments comprising greater than 35 percent of the volume, would be rated in the "poor" category and would be suitable for cover-soil use only if adverse factors could be effectively ameliorated.

REAPPLICATION OF SOILS

Selective soil handling procedures based on cover-soil ratings could substantially improve the potential for vegetation reestablishment. In areas where substantial surface disturbance would take place, surface soil judged to be of higher quality than underlying materials should be segregated and replaced in a manner which prevents contamination with lower quality materials. Surface soils generally have physical, chemical and biological characteristics which are substantially more conducive to vegetation establishment and production than underlying subsoils.

Additionally, surface soils contain seed and vegetative propagules which contribute to vegetation reestablishment. Preliminary results from a surface mine reclamation study in the Red Desert in Wyoming indicates that substantial reestablishment of the native plant community has taken place from seed and vegetative propagules in the reapplied topsoil (Taylor, 1980).

Since subsoils within Nevada and Utah are often more saline than overlying surface soils, surface soil which is to be replaced should be segregated from subsoil to prevent contamination. Gates and others (1956), in a study of soils associated with five vegetation types of the Utah Salt Desert, found that both the total salt content and the EC increased significantly with depth. Mean total soluble salt percentage ranged from 0.13 (for the 0-6 in. depth) to 1.04 (for the 36-60 in. depth). These data demonstrate that the blending of surface soil with subsoil would result in a plant establishment environment which has a much higher salinity than the original surface soil. According to the soil survey of the Penoyer area in Nevada (Soil Conservation Service, 1968), the majority of subsoils in this area have a higher EC (a measure of the total soluble salt content) than do the corresponding surface soils. Clearly, the revegetation potential of the Jarboe soil (which has an EC of 4 to 9 mmhos/cm in the 0 to 6 in. layer and an EC of 8 to 25 mmhos/cm in the 6 to 66 in. layer) and Papoose soil (which has an EC of 0 to 2 mmhos/cm in the 0 to 7 in. layer and an EC of 2 to 8 mmhos/cm in the 7 to 60 in. layer) would be reduced if the surface and subsurface soil horizons were blended during construction activities.

Avoiding the storage of excavated surface soil, through the process of direct reapplication, would be beneficial to the revegetation process. Potential gains from direct reapplication include the preservation of soil structure, microorganism activity and propagule viability (Schafer, 1979). Preliminary results from surface mine studies indicate that the reestablishment of native vegetation on directly reapplied topsoil is far greater than on topsoil stored for a period of over 2 years (Taylor, 1980). When stockpiling of surface soil is necesssary, keeping storage periods to a minimum would likely reduce the potential for adverse changes in soil quality.

When subsoil horizons are excavated as part of the construction process, the segregatic and reapplication of subsoil (including B and C horizon materials) would produce a rooting media which could aid in vegetation reestablishment (Power et al., 1979). If materials beneath the subsoil are disturbed, these spoil materials should be handled and disposed of in a manner which will not inhibit vegetation reestablishment. Spoil materials with characteristics which are potentially toxic to vegetation (such as those which are excessively saline) should be buried in a designated disposal site. Spoil which meets selective physical and chemical criteria, such as those proposed by the National Cooperative Soil Survey (Schafer, 1979), could be used to supplement surface soils or subsoils.

The grading and scarifying of subsurface materials prior to reapplication of segregated soils would enable uniform soil reapplication, reduce soil slippage, and enhance root penetration through the reconstructed profile. In locations where paved roads or permanent structures are to be placed, quality surface soils could be removed and subsequently used as a substitute for, or supplement to, surface soil in areas where original materials were shallow or of poor quality.

The potential for vegetation reestablishment on haul roads and construction staging sites would be improved if surface soil was removed prior to use of these

areas and then reapplied when these areas were no longer in use. The revegetation potential of these areas could also be increased by closing them to vehicular traffic, removing surfacing materials which might inhibit root penetration, and by ripping, plowing, and scarifying them prior to soil reapplication.

IMPROVEMENT OF EXISTING SOIL CONDITIONS

In many areas within the Nevada/Utah candidate siting region, the soil profile contains a hardpan which restricts root penetration and vertical water migration. The reconnaissance soil survey for Railroad Valley, Nevada (Nevada State Engineer's Office, 1971) identifies numerous duripans (a silica-cemented hardpan) beginning 10 to 20 in. beneath the soil surface. Landscape categories which contain duripans include "saline soils of the lakeplain" (Nadurargids), "finer textured soils of the smooth alluvial plains" (Nadurargids), and "shallow soils of the dissected fans and foothills" (Durargids, Durothids and Durixeralls). Post-construction plant establishment could be enhanced on hardpan containing soils by disruption of the hardpan during excavation or by subsoil cultivation procedures.

When surface soils are of poor quality, more favorable revegetation conditions may be accomplished by blending the surface soil with higher quality subsoil or overburden. This procedure has been demonstrated by Schuman and Taylor (1978), who found that a fertilized blend of 50 percent surface soil (having an EC of 3.5 mmhos/cm) and 50 percent subsoil (having an EC of 0.4 mmhos/cm) produced greater western wheatgrass and thickspike wheatgrass dry matter yields than did fertilized surface soil or fertilized subsoil when used separately. In the Penoyer area of Nevada, the Monte Cristo soil, which has an EC of up to 20 mmhos/cm for the surface soil and an EC of up to only 8 mmhos/cm for the subsoil, would likely benefit from surface soil/subsoil blending. When blending is used, much of the costs associated with soil segregation could be eliminated.

PRODUCING AN OPTIMUM SURFACE CONFIGURATION

The final surface configuration of the disturbed sites would greatly affect the potential for revegetation (Grim and Hill, 1974; Ivanovitch, 1974). By minimizing slope angle and length, surface runoff and erosion problems could be reduced. Final slope gradients of 3 horizontal to 1 vertical or flatter would contribute significantly to the success of revegetation and soil stabilization efforts (Cook et al., 1970; Lane, 1980). Installation of runoff diversion structures would also aid in controlling erosion (Becker and Mills, 1972). Inadequate attention to erosion control could lead to a loss of productive topsoil (containing valuable nutrients and seeds), and damage to emerging seedlings due to uprooting, abrasion, and burial by sediment. Dollhoph and others (1977) found that specific soil surface manipulations resulted in significantly different quantities of runoff water and eroded soil material. They reported that the total amount of runoff and discharged sediment was minimized by a dozer-basin treatment. Additionally, dozer-basins were found to increase soil moisture recharge. Hodder (1977) reports that deep chiseling is an effective aid in establishing vegetative cover on relatively flat slopes during the first growing season. He also indicates that gouging and dozer-basins are useful on moderate slopes and will conserve runoff water from storms and snow-melt. Proper contouring of disturbed areas would also be necessary to enable the use of seeding drills and surface treatment machinery.

APPENDIX C

SIGNIFICANT ANALYSIS QUESTIONNAIRE

NOTE: The following questionnaire was prepared using the conceptual project layout in Alkali Springs Valley, Nevada, as an example. This hydrologic subunit would be heavily impacted from M-X deployment following the conceptual project layout.

Consequences Which Are Specific to an

Individual Environmental Variable

1. To what extent will the effect alter the carrying capacity of the environment for the resource?

1	2	3	4	5
no change in carrying capacity		some reduction in carrying capacity		major reduction in carrying capacity

Over an area of about 5 square miles, the capacity of the land to support native vegetation will be reduced to zero, with no potential for revegetation, since this area will be paved or built upon. The remaining unquantified cleared area will have a reduced carrying capacity due to increased erosion, loss of productive soils, soil compaction and deposition of toxic materials. However, the potential for revegetation would exist over this area. Some parts of the watershed will be unaffected. Approximately 59 percent of the watershed lies within 0.5 miles of the known disturbance locations.

2. What is the effect of the disturbance on the viability of the resource?

1	2	3	4	5
no change in viability		some decrease in viability		major decrease in viability

If one considers viability to mean the quality of the native vegetation to reproduce itself, then the viability will be reduced to zero in cleared areas, reduced to a lesser degree in areas used but not cleared (marshalling areas, dump sites, etc.), and not influenced in other areas.

3. What is the effect of the disturbance on the quality of the resource?

1 — 2 — 3 — 4 — 5

no loss in quality — some loss in quality — major loss in quality

If quality is defined for native vegetation as an index of density, diversity, stability and productivity, then all directly and indirectly impacted areas will experience reduction in quality. About 59 percent of the watershed lies within about 0.5 miles of direct disturbance and would be expected to receive some degree of impact due to erosion, sedimentation, flooding, ORV use. Permanently paved or built upon area (approximately 5 square miles) will experience complete loss of quality.

4. To what extent will the effect be masked by normal variation expressed by the resource?

1 — 2 — 3 — 4 — $4\frac{1}{2}$ — 5

completely masked — some masking — no masking

The range of normal variation in the characteristics of native vegetation does not include the degree of change that will be experienced in construction areas. Some offsite impacts would be more subtle and could be confused with local site-specific variations in environmental characteristics or previous disturbance history. Ongoing field studies are designed to ascertain the likely offsite impacts of construction activities such as road building.

5. To what extent will the effect on the resource be masked by normal resource variability when the influence of potential future projects other than M-X are imposed ?

1 — 2 — 3 — 4 — $4\frac{1}{2}$ — 5

completely masked — some masking — no masking

With or without M-X, the range of normal variation in the characteristics of native vegetation does not include the degree of change that will be experienced as a result of potential future projects other than M-X.

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6. How rapidly will the resource recover from the disturbance effect if the effect is temporary?

1	2	3	4	$4\frac{1}{2}$	5
rapid recovery		slow recovery		Very slow	no recovery

Estimates of recovery rates of native vegetation in areas receiving less than 10 inches average annual precipitation are from decades to centuries (National Academy of Sciences, 1974). Alkali Spring Valley receives less than 5 inches of precipitation annually. Joshua trees in the southeastern section of the watershed may never reestablish.

7. How rapidly will the resource recover from the disturbance effect if the effect is permanent?

1	2	3	4	5
rapid recovery		slow recovery		no recovery

Native vegetation cannot reestablish in areas that lack a substrate suitable for plant growth.

8. To what extent will the resource recover from the disturbance effect in a reasonable time period?

1	2	3	4	$4\frac{1}{2}$	5
full recovery		moderate recovery			no recovery

If a reasonable time period is assumed to mean the lifetime of the M-X project, there will be no recovery in areas permanently disturbed. Very little vegetation will reestablish in temporarily disturbed areas in this time period.

9. To what extent will the resource recover from the effect when this effect is combined with other disturbances expected from M-X (cumulative effects)?

1	2	3	4	$4\frac{1}{2}$	5
full recovery		moderate recovery			no recovery

Within the lifetime of the M-X project, recovery of native vegetation from cumulative effects will range from limited to zero. Construction effects will be of greater significance than post-construction effects.

10. How geographically widespread is the effect of the disturbance on the resource?

1	2	3	4	5
localized effect				widespread effect

Although clearing of vegetation is localized, cleared and otherwise disturbed areas will be scattered throughout the watershed. Effects from dust, flooding, sedimentation and ORV use are expected to be widespread.

11. To what extent will the effect change the aesthetic value of the resource?

1	2	3	4	$4\frac{1}{2}$	5
no change in aesthetic value		moderate decrease in aesthetic value			major decrease in aesthetic value

Although cleared area will be approximately 2 percent of the watershed, these areas will be visible throughout, and 59 percent of the watershed lies within 0.5 miles of direct disturbance. The loss of Joshua trees is considered an aesthetic degradation. The open, natural character of the watershed will be permanently changed throughout the valley in a manner not pleasing to persons who regard open, natural landscapes as aesthetically pleasing.

12. What is the scientific or intrinsic value of the resource?

1	2	3	4	5
low scientific or intrinsic value		moderate scientific or intrinsic value		high scientific or intrinsic value

Native vegetation forms the basis of the food chain--all animal life, including human, is ultimately dependent upon plant life. Plants provide foods, medicines, structural materials and chemicals useful to many industries. Native vegetation stabilizes and protects valuable top soil from erosion and provides wildlife habitat. It is the only vegetation that will grow in the area without expensive improvements such as soil quality enhancement, fertilization and irrigation. The productive uses of plants, including Great Basin species, are far from being completely known.

ISSUE 1

Competition for Resources

1. How does a change in the effect affect the viability of the resource?

1	2	3	4	5

Answered under 2. above.

2. To what extent will the resource continue to be usable with the same level of quality and capacity for renewal that it previously had?

1	2	3	4	4½	5
no reduction in usefulness to humans		partial reduction in usefulness to humans			major reduction in usefulness to humans

Cleared and heavily disturbed areas will be lost from beneficial/ economically important uses such as livestock grazing. Even lightly disturbed areas will be of reduced value due to lowered productivity and spread of weeds, particularly Halogeton. Aesthetic and recreational value of the land will be reduced. The value of Alkali Spring Valley as a natural resource suitable for scientific study will be reduced.

3. What is the extent to which the resource will become limited to the point of threatening the carrying capacity of the area or developmental trends which have already been in motion for some historic period of time?

1	2	3	4	5

A combined loss of vegetation and degradation of vegetation will reduce the usefulness of the area. Some reduction of carrying capacity will occur. The amount of reduction will vary according to severity of impacts.

ISSUE 2

Constraint on Future Development Opportunities

1. Is the change in the effect observable relative to the potential variations in the baseline or trust or other competitors for these development opportunities?

1	2	3	4	5

N.A.

2. To what extent does the change in the effect produce a developmental constraint that is observable?

1	2	3	4	5

N.A.

3. To what extent does the change in the effect variable degrade the environmental resource which is or would be needed by other competitors?

1	2	3	4	5
no constraint on other future uses		moderate constraint on other future uses		major constraint on other future uses

N.A.

4. To what extent does the change in the environmental variable when combined with competing opportunities cause a considerable stress on some portion of the environment which would not occur if the competition were not there or if constraints were imposed on the developmental directions for the various interested competitors?

1	2	3	4	5

N.A.

5. To what extent is the change in the effect variable a significant modifier of other developmental actions which are planned to take place. For example, will it compete for the same space, will it cause that space to be unusable, will it require stress on limited resources, changes in transportation of goods, etc.?

1	2	3	4	5
no modification		some		major

The removal and degradation of native vegetation will seriously limit the economic value of the watershed as rangeland, because the number of head of livestock that can be supported will be significantly reduced. M-X will cause large areas of the watershed to be unusable or less valuable as grazing land.

ISSUE 3

Stress on Growing Communities

1. Is the change in the effect variable large or the same value as established standards for this particular effect?

1	2	3	4	5

N.A.

2. Is there a reasonable opportunity for recovery from changes in this effect in a reasonable period of time?

1	2	3	4	$4\frac{1}{2}$	5
complete recovery					no recovery

Recovery of native vegetation in arid lands has been estimated to require decades to centuries (National Academy of Sciences, 1974), so virtually no recovery is expected within the lifetime of the M-X project.

3. Will the quality of the area necessarily have to be changed in order to accommodate the changes in these effects?

1	2	3	4	5

N.A.

4. Will the change in these effects levels produce a permanent change in some sector of the environment and if so, will that change be in total contrast with other induced changes already in process for the future development of the area or will these permanent changes be in concert with other expected changes?

1	2	3	4	5
small				large

Facility locations and repeatedly disturbed areas will be permanently lost and no native vegetation reestablishment will occur. These changes will be of much greater magnitude than those of other projects foreseen in the area.

5. Will the change in the effect level be significant within the context of the uncertainties of the growth pattern of the impacted regions? That is, if one assumes a 10 percent potential fluctuation in either the compositional structure of the demographics or in the absolute value of the population growth will the changes due to M-X be significantly larger or approximately the same amount of much smaller than this 10 percent absolute change?

1	2	3	4	5

N.A.

6. Will growth trends in the area in terms of sectoral composition, population density, urban-rural transitions, and other uses of the land be modified significantly by M-X or will M-X's changes fit within the predicted trends for these areas?

1	2	3	4	5

N.A.

7. Will planning for these areas require significant funding specifically for the properties and requirements of M-X or can they be included in umbrella types of funding which would include the future plans of the area and those requirements of M-X which add stress to the growing communities?

1	2	3	4	5

N.A.

8. Will M-X require significant additional short-range planning or planning significantly accelerated relative to the planning required for the future development of the area?

1	2	3	4	5

N.A.

9. To what extent will funding be required to mitigate the effect on the resource?

1	2	3	4	5
no funding required to mitigate		moderate funding required to mitigate		major funding required to mitigate

The only mitigation strategy with significant potential for reducing overall impacts to native vegetation is implementation of a program for erosion control and revegetation. The cost of implementing such a program in arid lands is expected to range from a few hundred to a few thousand dollars per acre. These costs can be reduced if many aspects of the program are incorporated into the construction process, but the overall cost would still be substantial.

10. To what extent will the effect on the resource have significant economic or social consequences on communities within the study area?

1	2	3	4	5
no significant economic or social consequences				major significant economic or social consequences

The economic value of the land at this time is tied to its use as rangeland. Elimination of grazing in significant portions of the valley could have major economic impacts on local ranchers.

ISSUE 5

Preservation of Biophysical and
Cultural Resources

1. What is the legal status of the resources?

1	2	3	4	5
no legal status	state protected (game and nongame)	state protected or endantered	proposed federally protected	federally protected species (threatened and endangered)

All species of cacti and Yucca are state protected, although most are not rare. Protection is intended to discourage poaching of plants which have value to the landscape industry. Also, mechanical harvesting of the seed of single-leaved pinyon is not allowed under Nevada state law. All these species are typical components of native vegetation, and some occur in Alkali Spring Valley.

2. Will a change in the effect potentially indirectly affect those resources which are legally protected?

1	2	3	4	5
minimal likelihood of affecting a legally protected resource		moderate likelihood of affecting a legally protected resource		high likelihood of affecting a legally protected resource

Removal of native vegetation would be likely to include significant numbers of some species of protected plants.

3. Will a change in the effect require either behavioral modifications or changes in life patterns in order to preserve the specific cultural resources?

1	2	3	4	5

N.A.

4. Will a change in the effect lead to a permanent degradation of some portion of the ecosystem which the cultural resources depends on?

1	2	3	4	5
none		some		significant amount

An unquantified area of native vegetation will be permanently lost or degraded. Future land use will therefore be restricted. The spread of Halogeton, expected to be significant in Alkali Spring Valley, will deter grazing of livestock in a major portion of the watershed.

5. Will a change in the environment effect lead to a degradation of some portion of the ecosystem which contains resources needed for the preservation of a cultural or biological resouce?

1	2	3	4	5
no degradation		some		major

Vegetation removal and degradation will result in permanent or temporary soil degradation, which will decrease the likelihood of revegetation and therefore the potential use of the area as wildlife habitat.

6. Will a change in the effect level cause a degradation in the quality or aesthetics of the particular resource that is to be preserved, and will this be a major or a minor change in the aesthetic or quality feature?

1	2	3	4	5
no degradation of quality or aesthetics		moderate degradation of quality or aesthetics		major degradation of quality or aesthetics

N.A.

GENERAL CONSEQUENCES

1. Are the consequences such that the portion of the ecosystem or society will not recover at all?

1	2	3	4	5

no likelihood of irreparable damage to ecosystem — moderate likelihood — certain irreparable damage to ecosystem

Cleared areas where permanent facilities are placed, plus acreage where vegetation is heavily and/or repeatedly disturbed will not recover. Those animals populations that rely on this resource are also not likely to recover.

2. Are the consequences such that the impact may be large, but the recovery processes will overcome the damage in a reasonable period of time?

1	2	3	4	5

full recovery — partial recovery — no recovery

Recovery processes are expected to overcome the damage in temporarily disturbed areas within decades to centuries (National Academy of Sciences, 1974). Permanently disturbed areas will never recover.

3. Are the deleterious effects measurable?

1	2	3	4	5

not measurable — measurable with difficulty — readily measurable

The complete loss of native vegetation on a permanent or temporary basis can be readily measured. Other deleterious effects include decreases in density, diversity, and productivity of vegetation and modifications of soil parameters. These are measurable with some difficulty, and <u>accurate baseline data is necessary</u>.

4. Will a change in the effect change the functional relationships existing within the ecosystem and will this cause a change in either the carrying capacity or other characteristics of viability associated with the system?

1	2	3	4	5
no change in functional relationships		moderate change in relationships		major change in relationships

The removal of native vegetation will result in loss of wildlife habitat and therefore loss of wildlife on a temporary or permanent basis.

5. Do these deleterious effects or consequences result in degradation of other measurable environmental variables?

1	2	3	4	5

All biological resources and all land uses will be affected by vegetation loss or degradation.

6. Although the environmental effect itself may not be significant within the framework of the first five criteria, will it when measured in conjunction with certain other critical environmental variables produce changes that are observable within the framework of the criteria of the five standards?

1	2	3	4	5

N.A.

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